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PUBLISHED MONTHLY by Popular Science Publishing Co., Inc., 355 Lexington Ave., New York, N. Y. 10017

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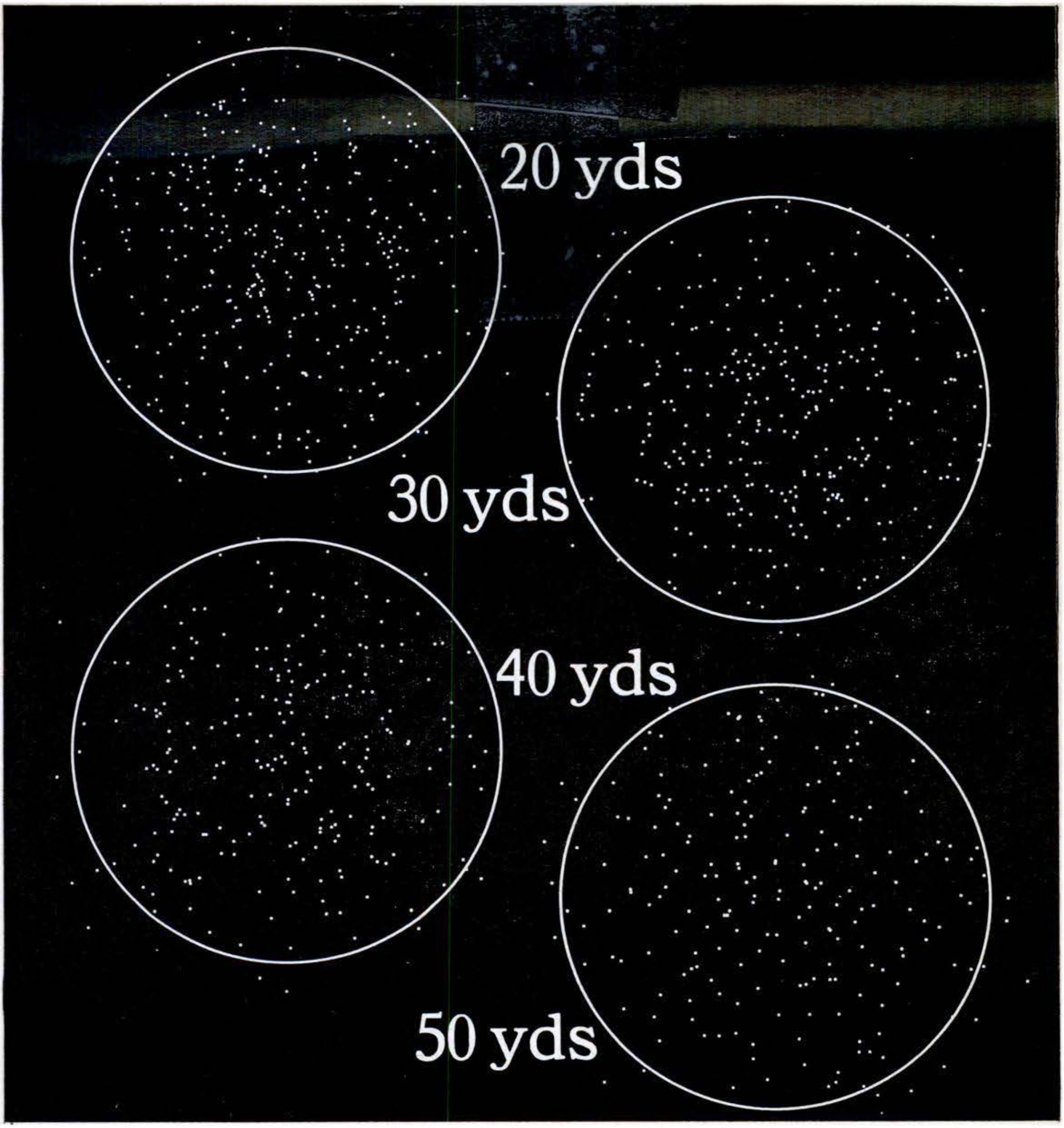

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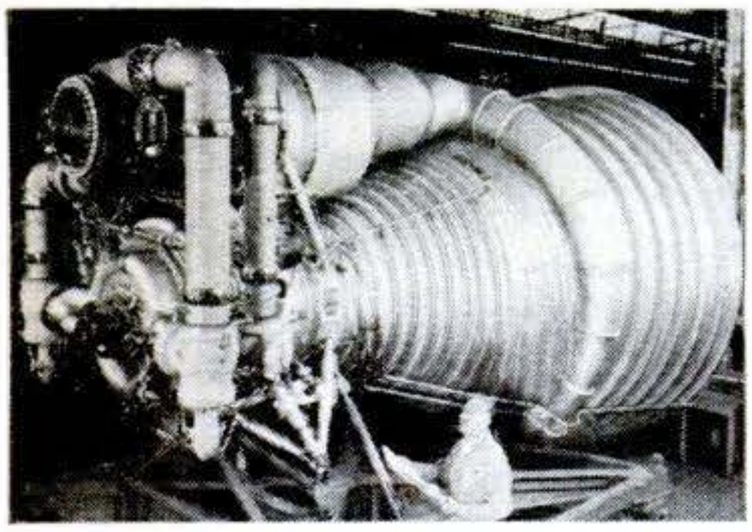
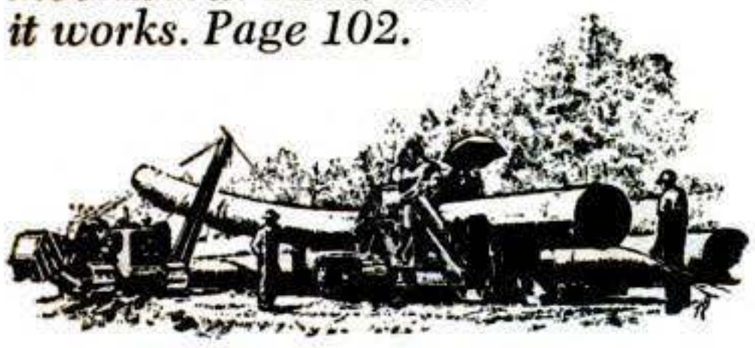
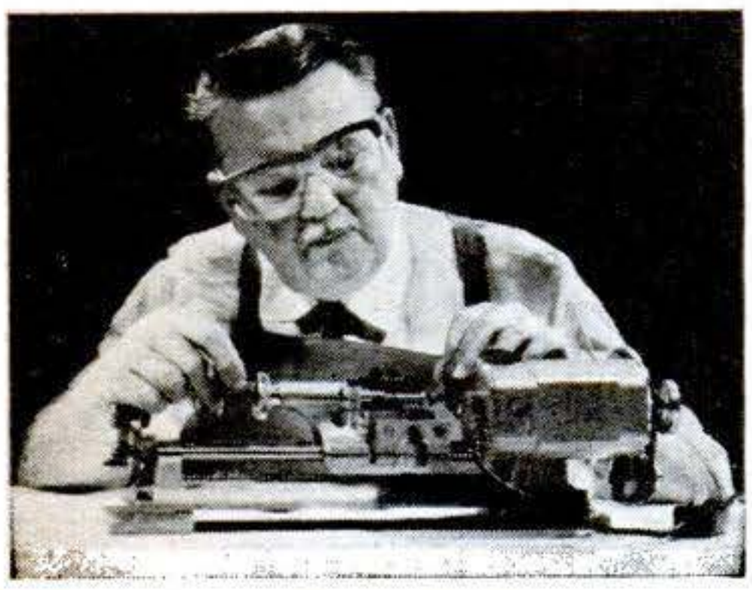


F-1, most powerful rocket engine in the world, has the muscle to lift 3,000 tons moonward. Read how it works. Page 102.



How they build a pipeline to carry 25 million gallons of oil products a day. Page 130.



Shop-expert Harry Walton tells about the big things a little lathe will do. Page 146.

25 Pages on the 1964 Cars

THE '64 LOOK: A COLOR GALLERY OF NEW MODELS PLUS A PREVIEW OF NEXT YEAR'S WORLD'S FAIR

F-85 • Galaxie • Comet • Tempest • Buick
Studebaker • Rambler American • Chevy
Plymouth • Dodge • Thunderbird • Mercury

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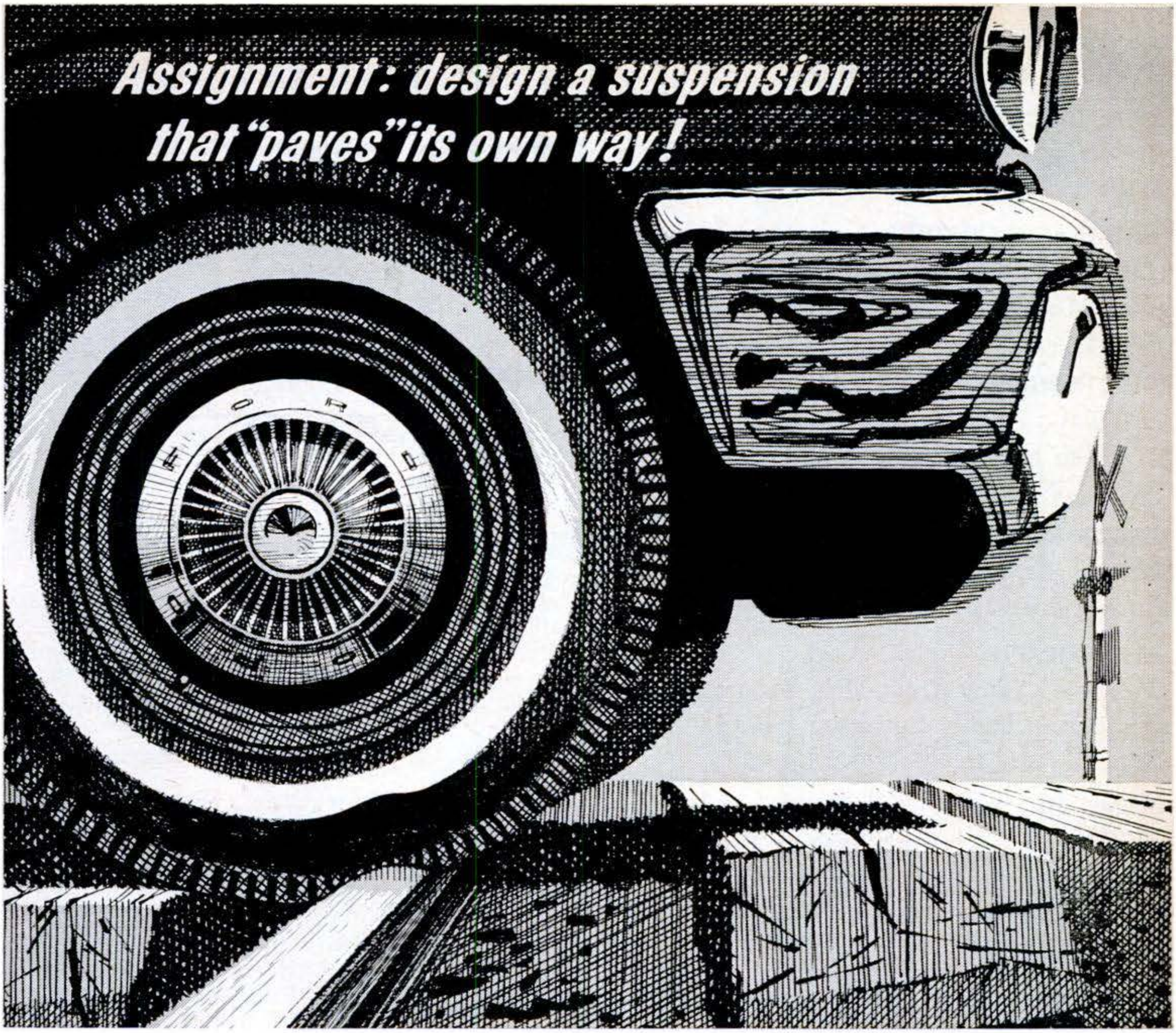

Result: "Cushion Recoil" provides a dramatically smoother ride in new Ford-built cars

The challenge given Ford engineers was to design suspensions that would permit wheels virtually to roll with the punches. The solution? Exclusive Cushion Recoil suspension action in all new Ford-built cars gives cushioning action in a fore-and-aft plane as well as vertical. This two-way action smothers jolts, helps keep thumps and bumps from reaching the body and helps Ford-built bodies stay quieter, last longer.

Engineering excellence gives you other big benefits in Ford-built cars. Bodies are rigidized to be quieter and super strong—with reinforced roof, extra-strength body members and tighter welded construction. Service-saving features like self-adjusting brakes and extended major chassis lubrication intervals reduce your car cares.

These are just a few of the engineering achievements behind Ford Motor Company's success in bringing you cars that last longer, need less care and keep their value better.

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PS readers talk back

Fast Answers to Fast Driving

"The Fine Art of Fast Driving" [Aug.] was informative and extremely deadly! Do you plan a follow-up article on the number of accidents and deaths stimulated by your story? The only thing you omitted was a set of instructions for the sane drivers who will be cut off and forced off the road by the speed maniacs who can't wait to cut across two lanes of traffic to see how fast they can take a corner.

MICHAEL HERMAN, Lawrence, N.Y.

. . . Not only does your European editor recommend using two lanes of a 4-lane highway to take a corner at 70-80 m.p.h., but he flatly states ". . . with 300 horsepower you stay in the fast lane."

I know of no bad driving practice that leads more easily to accidents than these two, unless it is Scott's third bit of bad advice: pass a "spaced-out string of cars" all at once with a great burst of speed.

Sure it's easier to take corners if you use up the other guy's road. Sure it's good for the ego to stay continually in the fast lane assuming that no one ought to go faster than you choose. And sure a great burst of speed (he was going 80 and then "floored the pedal") will get you past a line of cars unless No. 3 or No. 4 decides to pass at the same moment. But at what cost in broken laws and mangled bodies. Were you serious in recommending cut corners, fast-lane hogging, and zoom-passing at close to 100 m.p.h.?

WALTER S. HAYNES, Sarasota, Fla.

. . . As an owner of an MG and one who prides himself on the ability to safely get from one place to another rapidly, I must protest on two points:

The technique you describe for a fast turn is correct, but you go too far. It is unnecessary to use two lanes to navigate a turn. I take pride in the fact that I can take a high speed turn without crossing into another lane. By lengthening the radius of the turn as you ad-

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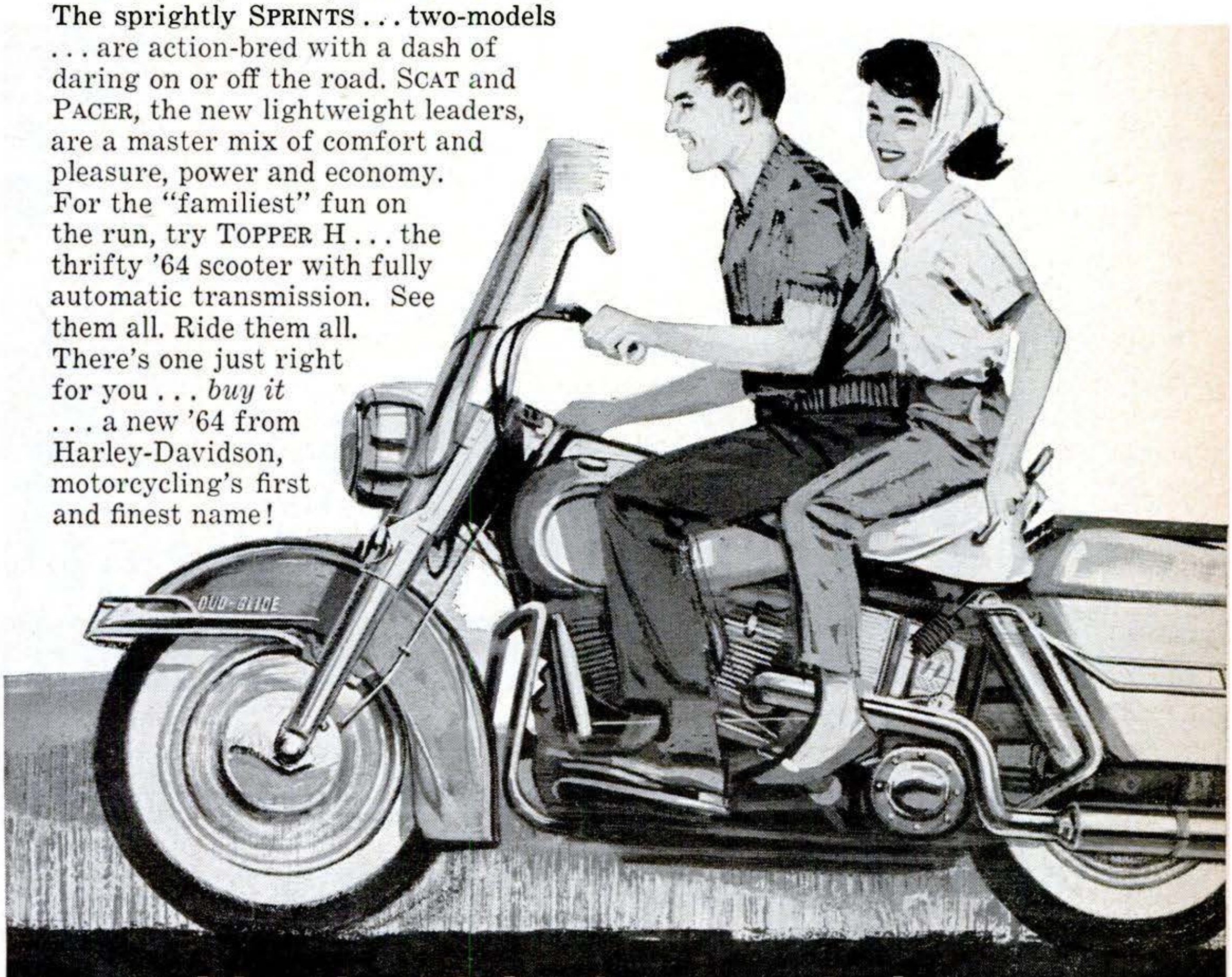

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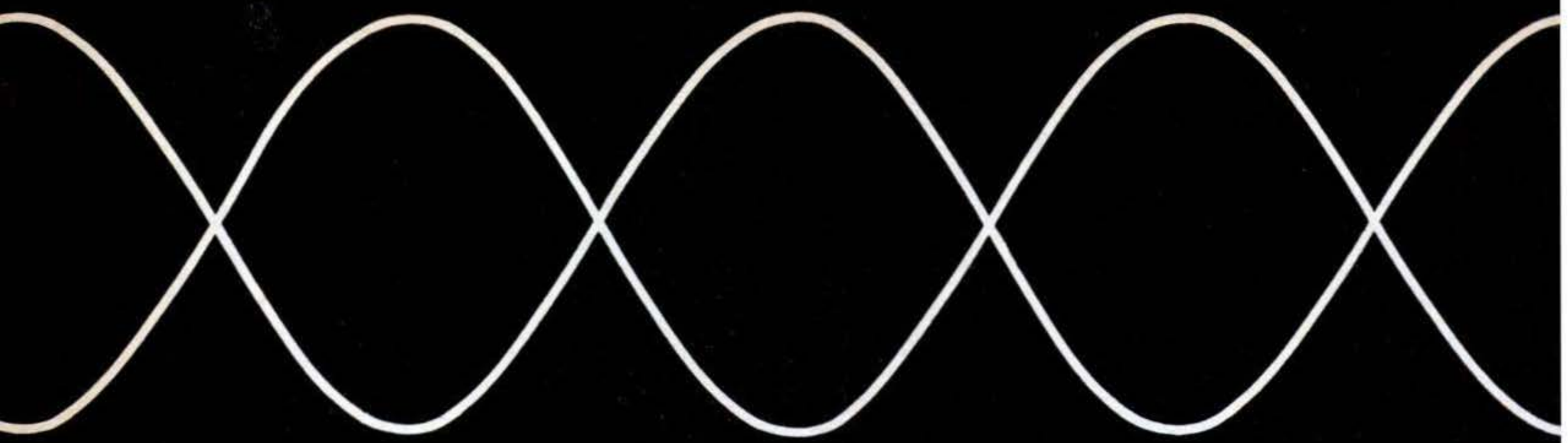

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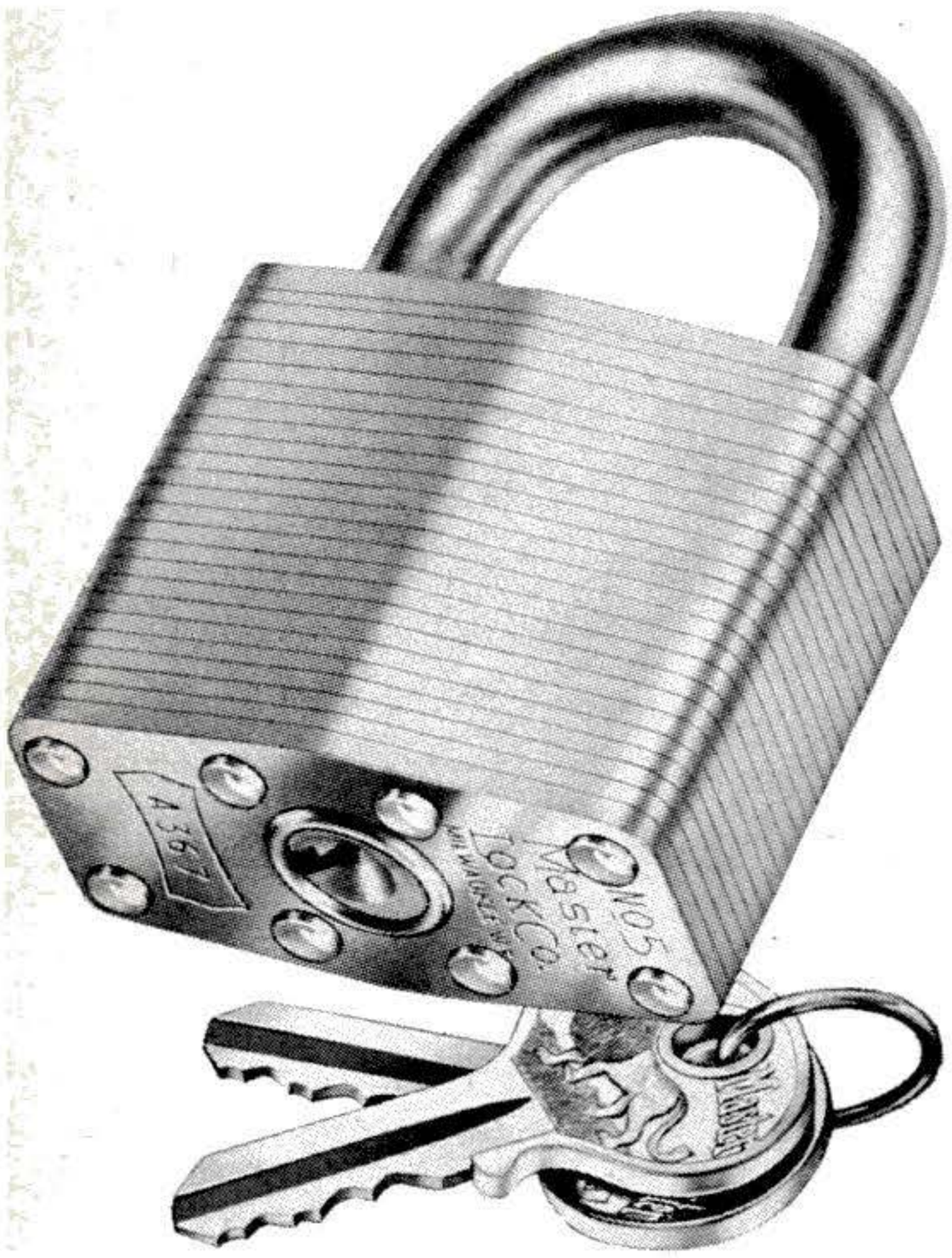

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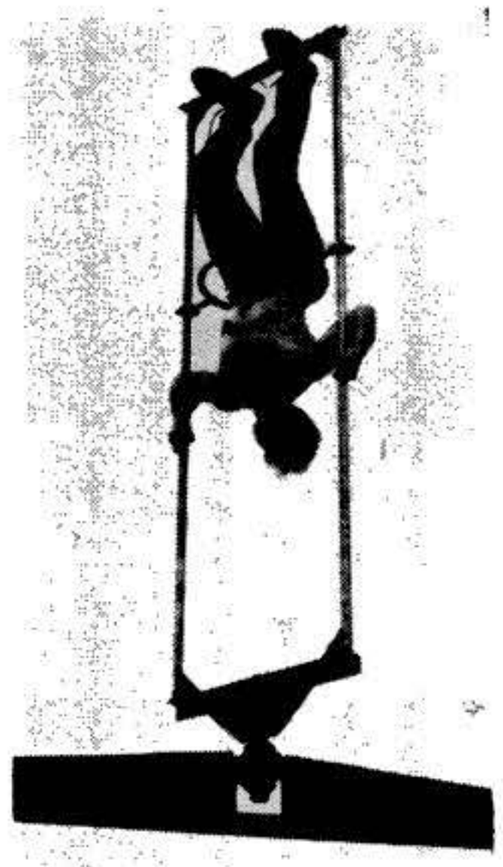
PS readers talk back continued

vise, I can handle any turn up to 85 m.p.h. I doubt anyone needs more than that.

I would also like to mention that the left lane is the passing lane, not the "fast" lane. If everyone would keep this in mind, we would have fewer left-lane drivers who go 5 m.p.h. under the speed limit and cause those frustrating tie-ups.

MARK ELLMAN, Eastchester, N.Y.

Swing and Squat Not for Him



I was not impressed with the physical-training swing for spacemen ["Picture News," Aug. p. 44] after I built one for myself.

Rotating around the bar at 45 r.p.m. and able to release both hands with no tie-downs seemed like little for all my work. I was quite disappointed. My bent position is to maintain a high r.p.m. The idea is to squat and stand at the right moments.

I suggest free falls from 8,000 feet (they're more fun anyway).

S. E. MORRIS, Hamilton, Ont.

The Model T Rides Again

Everett Ortner ["Any Dope Could Drive a Model T," July] mentions the clutch as if it were a conventional clutch such as used in present-day automobiles. The three bands he mentions were a separate "clutch" for low, high, and reverse, similar to those in modern automatics. The brake pedal operated brakes on the rear wheels by means of steel rods, not in the transmission. If memory serves me right the hand brake, when fully applied, set the wheel brakes and depressed the forward pedal to engage the low band, thus engaging the transmission for parking.

ONUS M. COMER, Novato, Calif.

. . . The old Model T had plenty of idiosyncrasies, frinstance:

Compression starting: Modern cars start by moving the key past the ignition ON position to START, where it energizes the starter circuit, but the Model T, under the proper conditions would often start merely by turning the key to the ON (battery) position! If, at the time the engine was shut off, a piston happened to go up on the compression stroke and stop just past top dead center, here would be a cylinder all charged, ready to fire and push the piston

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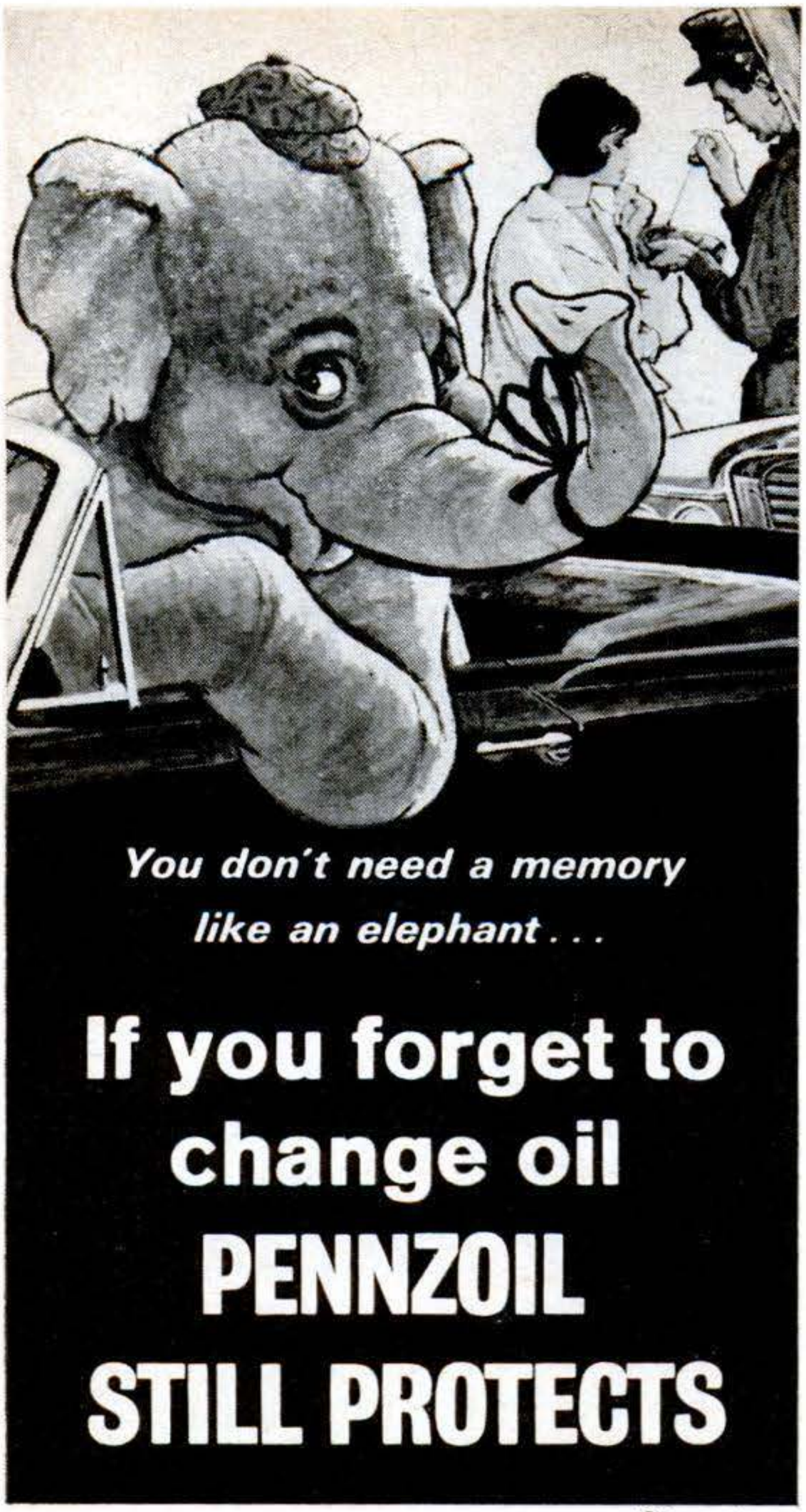

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PS readers talk back continued

down if a spark occurred at the spark plug. With the vibrator coils furnishing a continuous spark to the plugs all the time the timer was in contact (which must have been 15 to 20 degrees of crankshaft rotation), the engine would often start when you turned the switch to battery! I have had this happen to a dead cold engine after priming by cranking and choking with the ignition off, then turning to battery to really try to start the car.

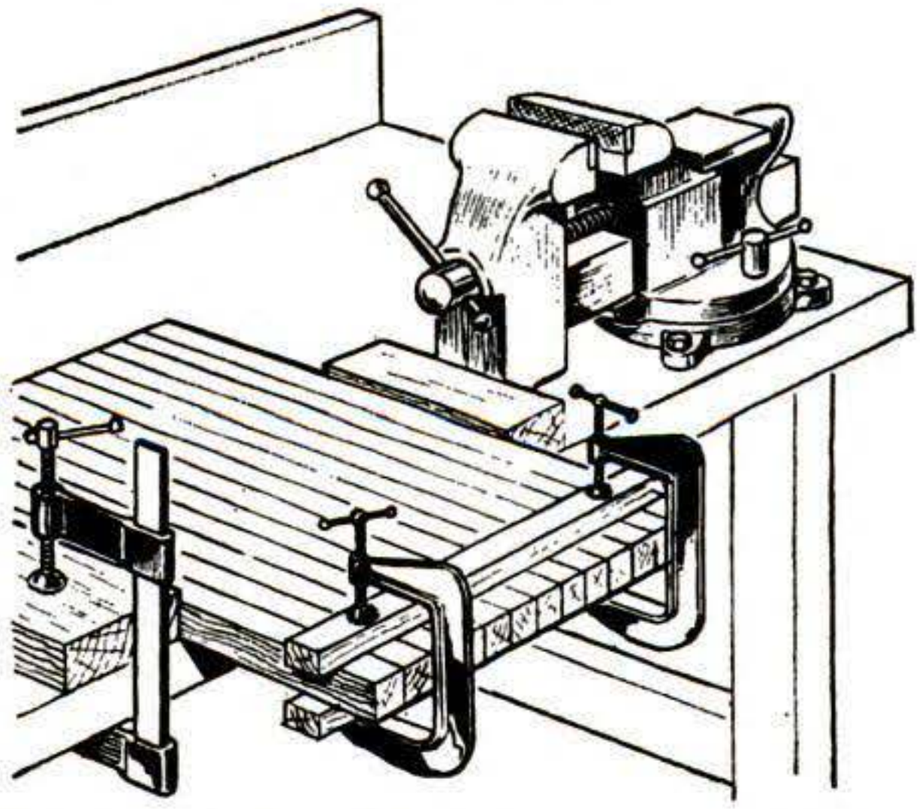
Cold weather stopping: It was common in winter to see a Model T sliding to a stop with one rear wheel revolving forward, the other backward! With the brake on the transmission, you could lock the drive shaft. But if one wheel had traction and the other was on ice, the car would keep on moving forward, the rear wheels revolving oppositely and the axles rotating on the spider gears in the differential. No limited-slip differentials in those days!

But Model Ts were tough. I once pulled the pan off my Model T and found the engine full of sand. Sand everywhere it could lodge on a flat surface. I must have dipped too deep in the barrel of crankcase drainings I got my oil from! But it never hurt the engine a bit.

EDGAR D. BOCKES, Fairport, N.Y.

Tip on a Tip for Gluing

I can add to that dodge on using a vise to substitute as a clamp ["Short Cuts and Tips," May, p. 116]: To keep the boards from buckling under pressure, sandwich the aligned boards



at the outboard end between two more boards longer than the width of the work.

TOM KENT, Costa Mesa, Calif.

Save Your Pennies!

I ran a battery service station so the use of pennies to prevent battery corrosion [July] interested me. Even on bad cases, I found sheep grease, mutton tallow, or lanolin most effective. Lanolin is the most expensive but the others work as they all have the same base. I recommend using a wool-felt washer about ¼" thick,

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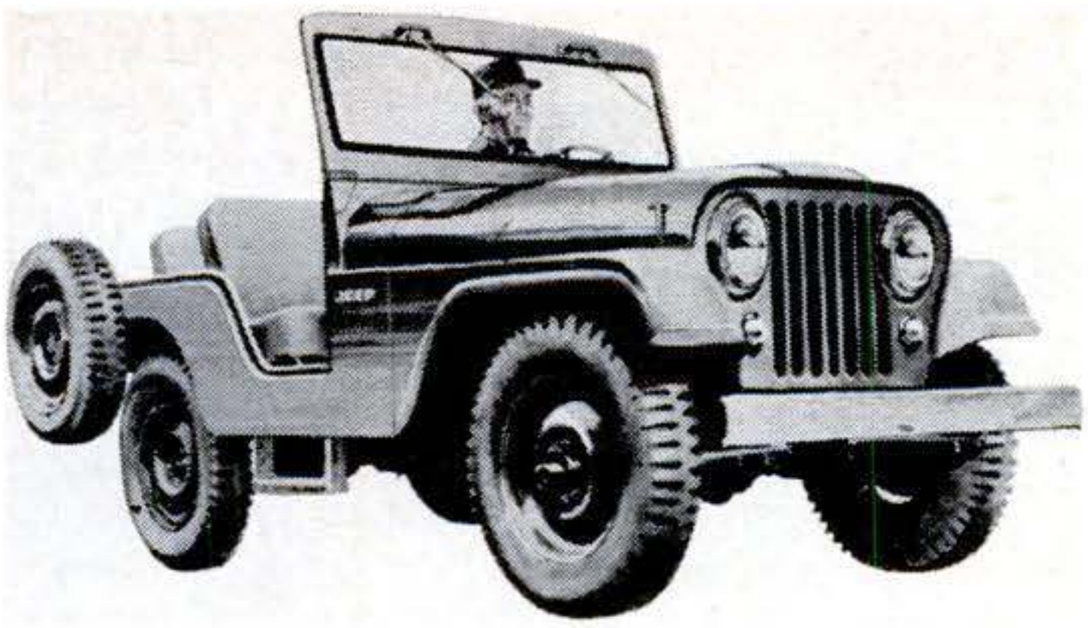

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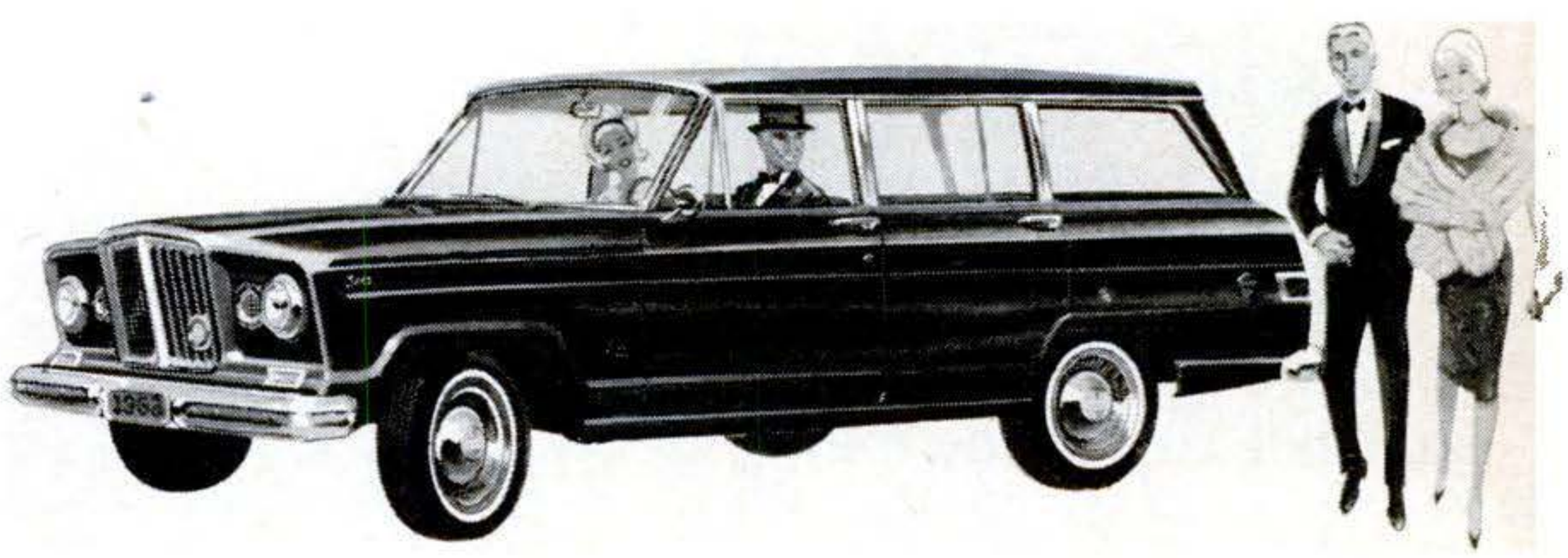

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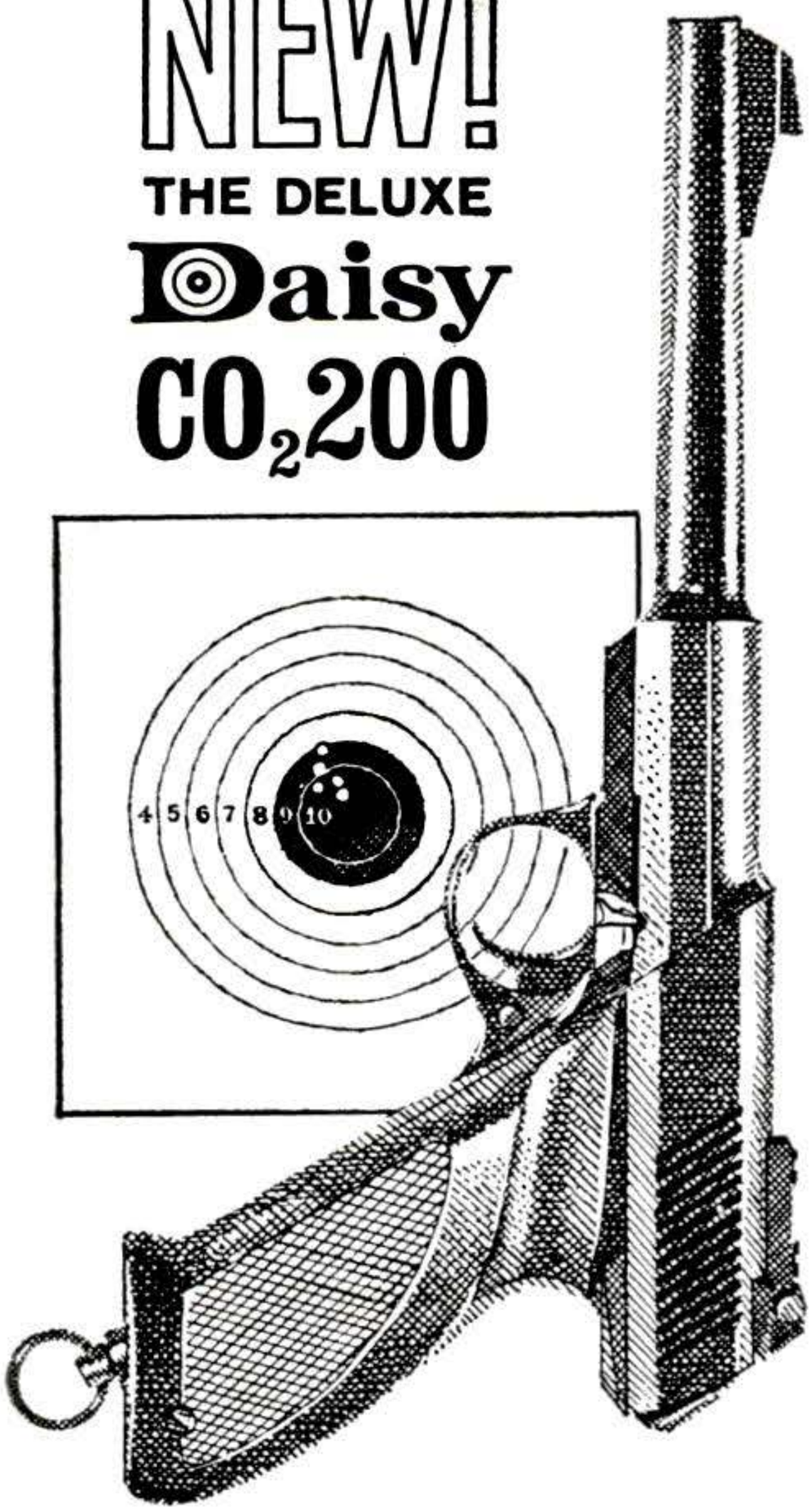

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PS readers talk back continued

soaked in the grease until thoroughly saturated. Fit this on the positive post (it should be a snug fit), then put on the battery cable. After tightening solidly, brush more grease over post and connector, and forget corrosion.

Vaseline and other greases won't do the job as they haven't the right base. I use this same kind of grease when cutting threads on steel, copper, or brass rods. It melts on the work ahead of the die and keeps it lubricated.

ARCHIE R. BAKER, Pawtucket, R.I.

. . . When I was in the garage game some years ago, I made about 250 acid storage batteries. My advice: Wash your battery with soap and water and you will have no corrosion troubles.

C. E. DENSMORE,
Ozone Park, N.Y.

. . . The battery in my '58 Chevy Bel Air is the original, with 76,000 miles of use. Is this unusual?

VINCE YEZZI, Philadelphia.

You kidding? It's miraculous.

Of Fords and Twomblys

George De Angelis ["Re-Creating the Three-Hoss Shay," June] had quite a problem getting the two full elliptic springs at the front of his reproduced Quadricycle. Henry Ford didn't have any trouble getting his. He used a pair of wagon-seat springs, available everywhere at that time.

In 1916 I had a Twombly Cycle Car. Glenn Twombly used an almost exact duplicate of the Ford chain-drive rear axle. I had to buy axle shafts by the half-dozen, and carry a spare all the time.

The car's 30" wheels were motorcycle wheels, instead of the bicycle wheels Henry used. Since they weren't strong enough for a car, turning a corner a little fast meant a broken spoke. I bought wire spokes by the dozen, and any time I heard the ping of one breaking I knew it meant getting out and putting in another befor several more broke. I'm glad the "good old days" are behind us!

G. D. SKELTON, Capistrano Beach, Calif.

. . . In Devon Francis' article on driving the Quadricycle [June], I discovered one small mistake. The date of the vehicle's first run was June 4, 1896, not June 6. Incidentally, the time was about 4:00 a.m.

GEORGE DE ANGELIS
Ford Motor Co., Dearborn.

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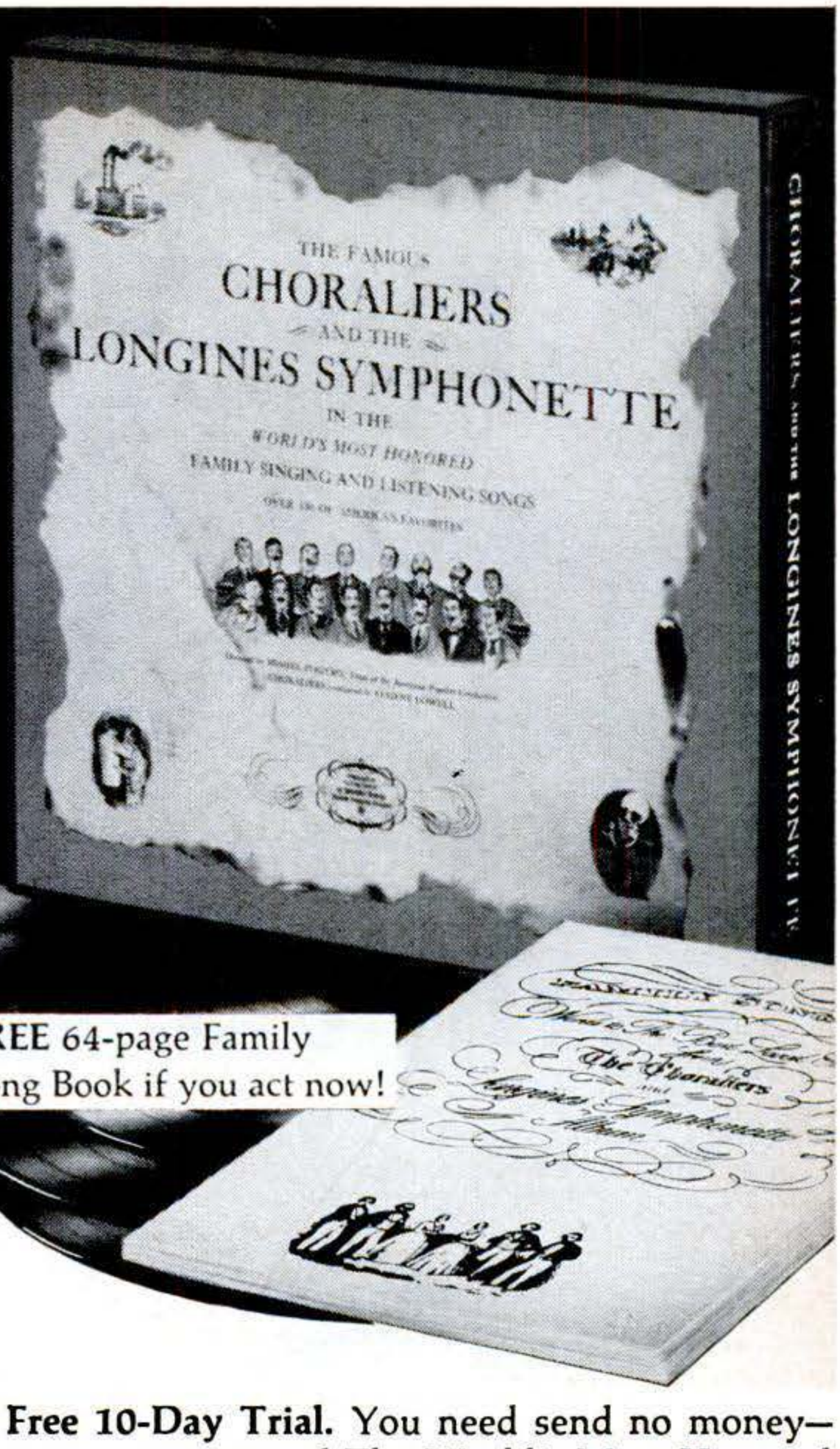

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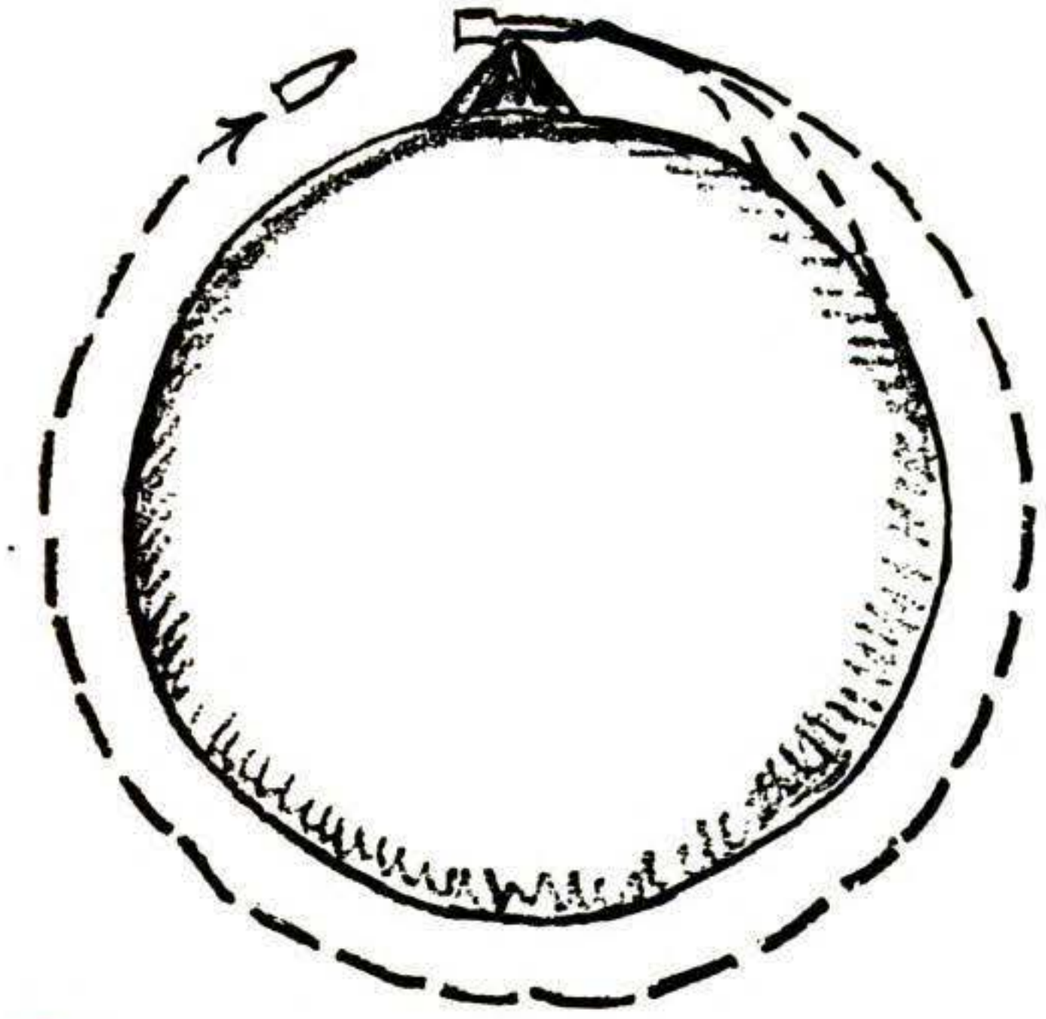
Dr. von Braun, right, and Robert C. Seamans Jr., Associate Administrator, NASA, discuss task of a spaceman. Ears of the one in background don't burn—he's just a dummy in a space-capsule exhibit.

Dr. Wernher von Braun Explains:

Why a Satellite Stays Up



Q ***What makes a satellite go into an orbit?***

A Imagine yourself standing on a high mountain peak, well above the atmosphere, firing a gun in a horizontal direction. (See my sketch above.) The shell, after leaving the gun barrel, will first fly horizontally. But soon the earth's gravitational pull bends the trajectory downward, as in the shortest of the paths in the sketch.

Reload the gun with a more powerful charge and the shell will fly farther, as shown by the next-longer path in the sketch. Its trajectory will be less deflected because the centrifugal force (as it follows the earth's curvature) is increased by its higher speed, and more effectively counteracts the earth's gravitational pull.

If you could use a charge powerful enough to give your shell a velocity of about 4.9 miles a second (17,600 m.p.h.), *the curvature of the downward-bent trajectory would become equal to the curvature of the earth.* The shell would keep flying and flying, and about 85 minutes later you'd better take cover—because the projectile, having gone all the way around the earth, would approach you from behind and hit the breech of the gun in the rear. The shell would have traveled in a circular orbit, the longest and globe-circling path in my sketch. If you don't believe it, ask John Glenn, Scott Carpenter, Wally Schirra, or Gordon Cooper.

In more general terms, this is what makes an orbit tick, and decides what kind of an orbit it will be:

A circular orbit occurs whenever a small

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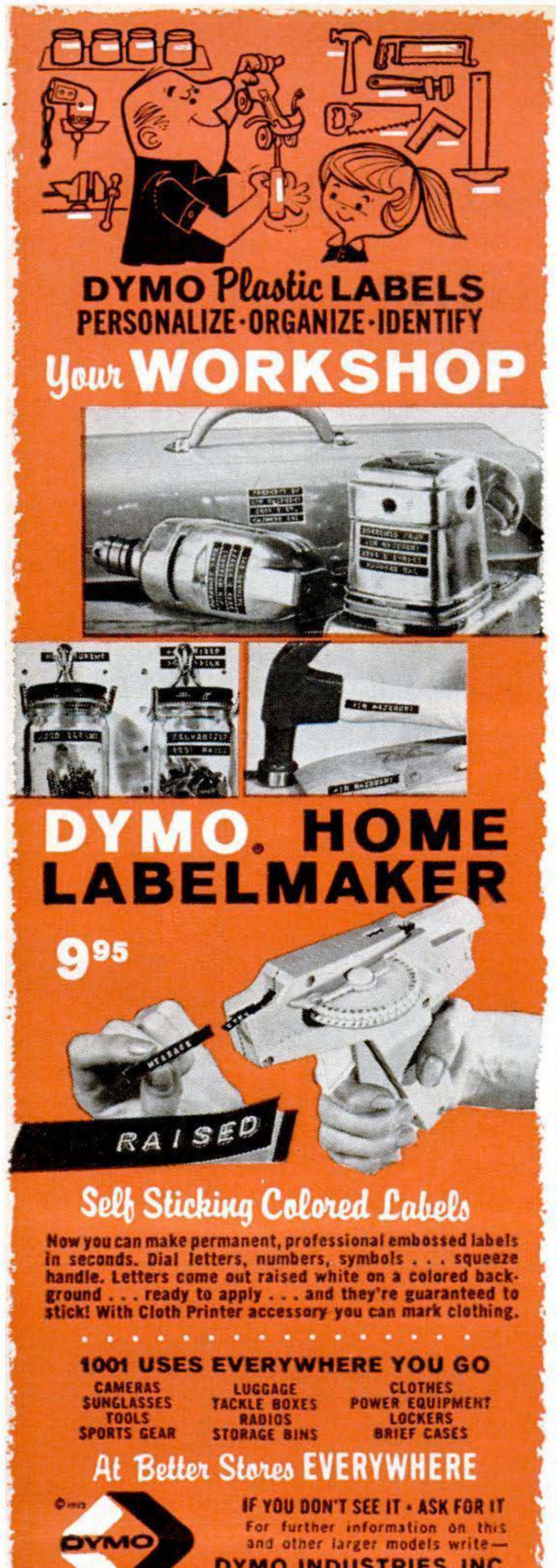
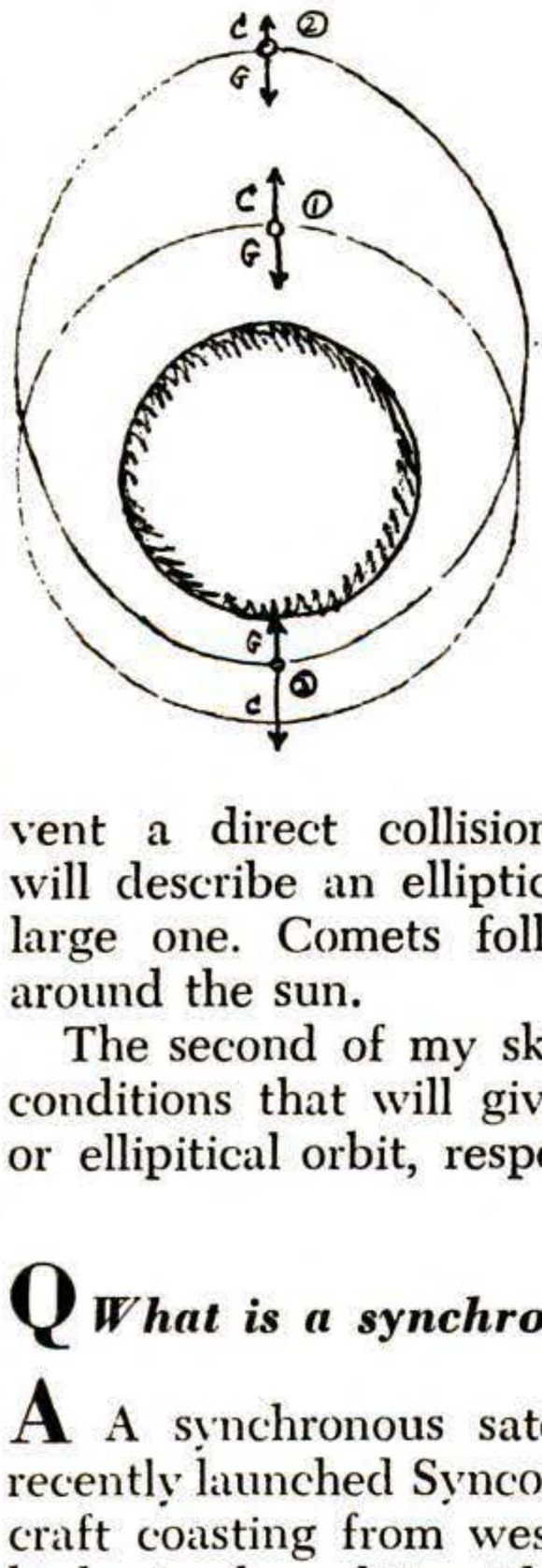


Dr. Wernher von Braun continued

mass, traveling through the gravitational field of a big one, happens to have a speed at which the centrifugal force is precisely strong enough to balance the large body's gravitational pull. This precision exists, to a high degree, in the orbiting of the moon around the earth, and of the earth and Venus around the sun.

If the balance between gravitational and centrifugal force is not perfect, but the centrifugal force is strong enough to pre-



① Centrifugal force C equals gravitational force F. Result: circular orbit

② and ③ Centrifugal force C larger or smaller than gravitational force F. Result: elliptical orbit

vent a direct collision, the small body will describe an elliptical path around the large one. Comets follow elliptical orbits around the sun.

The second of my sketches sums up the conditions that will give rise to a circular or ellipitical orbit, respectively.

Q ***What is a synchronous satellite?***

A A synchronous satellite (such as our recently launched Syncom No. 2) is a spacecraft coasting from west to east in a very high circular orbit, with a period of revolution of exactly 24 hours. An additional requirement is that the plane of the orbit must coincide, at least fairly nearly, with the plane of the equator.

Since the earth likewise revolves about its axis from west to east once every 24 hours, and since the earth's axis is at right angles to the plane of the equator, a synchronous satellite will appear to stand still, forever—directly above one particular spot on the equator. (Or if it has been launched on a path somewhat inclined to the equator, as in the case of Syncom No. 2, it will appear to move back and forth

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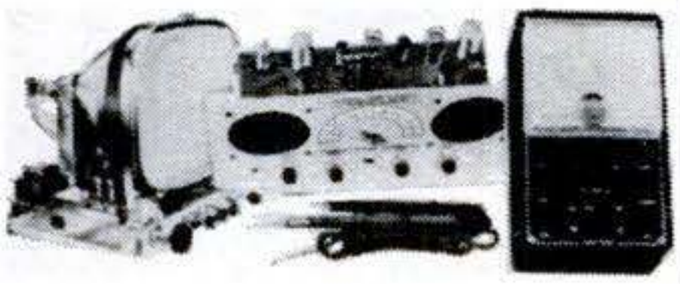

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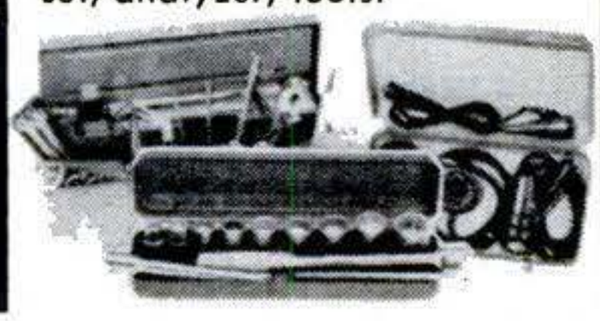

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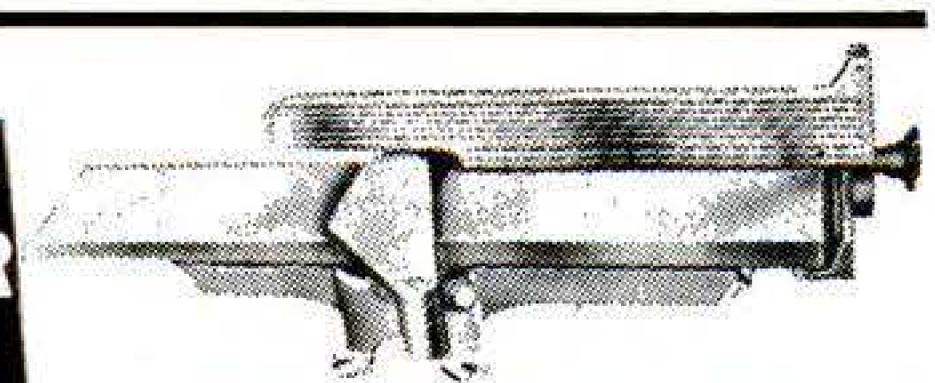

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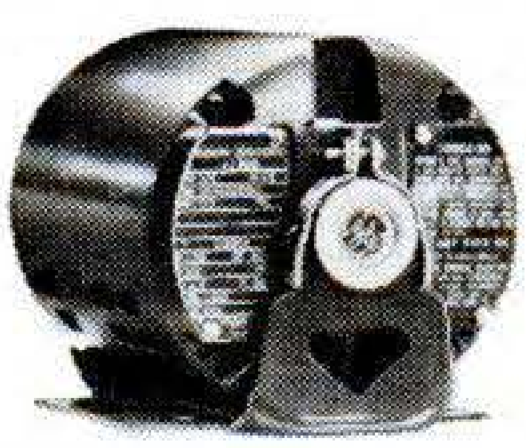

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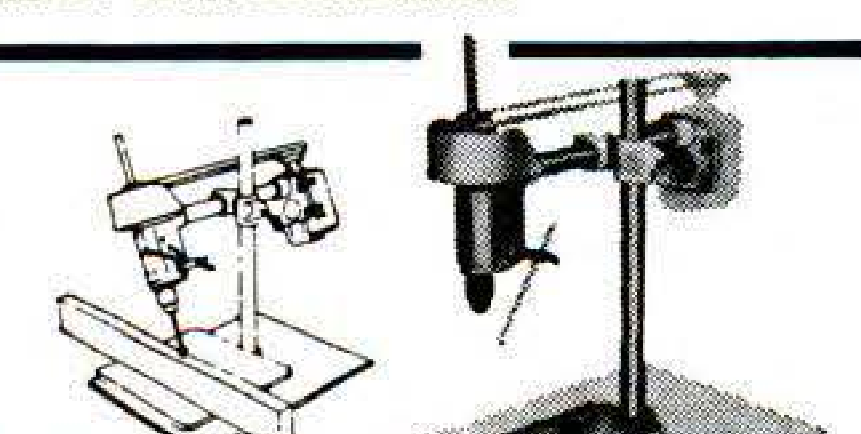

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Dr. Wernher von Braun continued

with a figure-8 motion above such a spot. As is required for a 24-hour period of revolution, its height is always 22,300 miles above the earth's surface.

Synchronous satellites are of great interest for global communications. Because of its great distance from earth (about six earth radii), a 24-hour satellite is simultaneously visible from a vast portion of the globe. For example, such a satellite "hovering" above the Amazon delta in Brazil would be in direct line-of-sight contact with places as far apart as Seattle, Thule (in Greenland), London, Rome, Cape Town, Buenos Aires, Los Angeles, and parts of Antarctica. As a never-setting variety of the famous Telstar satellite, it could serve as a permanent telephone or television relay station, linking North America to Europe, Africa, and Latin America.

Such a communications service would use microwaves—which can be beamed up to the synchronous satellite with the help of huge ground-based dish or horn antennas. The satellite itself need not have a directional antenna. It simply feeds the received signal into a solar-powered transmitter, and retransmits the amplified signal back to earth, on a different frequency.

Microwaves permit the use of a great number of adjacent frequencies, without cross talk. Thus a single synchronous satellite can handle many simultaneous telephone conversations and television programs.

Three synchronous communications satellites in the same orbit, spaced 120 degrees apart, could cover the entire earth (except for the areas around the North and South Poles, where all three satellites would be a trifle below the horizon).

Due to the satellites' enormous altitude, the travel time of the electronic signals from the earth's surface to the satellite and back will amount to almost one-third of a second. While this is immaterial for television, the time lag will be quite noticeable in telephone conversations. ■■

Dr. von Braun will consider answering questions from readers of POPULAR SCIENCE in the magazine, but he cannot undertake to answer each one by mail. Letters to him should be addressed in care of POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y., 10017.

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Let me explain! I don't care how poorly organized your mental powers are today — how difficult it is for you to concentrate . . . how bad your memory may be . . . how much a prisoner you are of crippling mental habits **. . . how long it takes you each morning to get your mind going with adding-machine speed and certainty!**

I BELIVE THAT YOUR MIND IS WORKING TODAY AT ONLY 5% TO 10% OF ITS TRUE POWER — SIMPLY BECAUSE YOU DON'T KNOW THE RIGHT WAY TO FEED IT DIRECTIONS!

Simply because you don't know the right way to feed your mind problems — **so clearly and logically that those problems half-solve themselves before you even touch them!**

Simply because you don't know the right way to feed your mind facts, figures and names and faces — **so they burn themselves into that mind in such picture-form that you remember them forever!**

Simply because you don't know the right way to feed your mind a FULL CHARGE OF ENTHUSIASM — so that it revs up instantly every morning . . . so that it operates at full power, not for just a few brief minutes each day. BUT FOR AS MUCH AS 8 TO 10 FULL HOURS AT A STRETCH!

Mind Power Is A Trick! I'll Teach It To You In One Weekend!

Yes! Problem-solving is a trick! Concentration is a trick! Memory is a trick! Habit-breaking is a trick! And, above all, generating the will power that means success IS A TRICK! Mind power can be made to order — you don't have to be born with it! The secret of a fast-acting, full-power, THINKING MACHINE MIND is as simple as tying your shoelace! **And I'm willing to prove it to you without your risking a penny! Here's how!**

The Very First Hour After You Pick Up This Book, You Will Perform A Feat Of Mind Power That Will Astound Your Friends!

All I ask from you is this. Let me send you — at my risk — one of the most fascinating books you have ever read. When this book arrives, set aside a few moments each day from the following weekend. Glance through just one chapter. **And get ready for one of the most thrilling weekends of accomplishment in your entire life!**

What you are going to do in that very first hour you receive the book, is this. Turn to page 144. Read three short pages — no more! And then, put down the book. Review in your own mind the one simple secret I've shown you — **how to feed facts into your mind so that they stay there — permanently — as long as you wish!**

Then put this simple trick to work for you — that very same hour!

Call in your family or friends. Ask them to make a list of any TWELVE facts, names or objects they wish, as fast as they wish. Have them write down the list so they won't forget it! **But, as they give you each fact, YOU are going to perform a simple mental trick on that fact, that will burn it into your mind, IN PERFECT ORDER, as long as you wish!**

And then — INSTANTLY AND AUTOMATICALLY—you are going to repeat that list, backwards and forwards, in perfect order, exactly as if you were reading that list in your friend's hand! And you are going to have one of the most exciting moments of your life, as you watch the expression on those people's faces as you reel off those facts as though they were flashing on a screen on the inside of your memory!

Thrilling? Yes! **But also one of the most profitable secrets you will ever learn.** For that list of twelve facts can just as easily be an appointment schedule — with each appointment flashing automatically into your mind at just the right time and place that you need it! Or a shopping list — or the outline of a speech — or a sales presentation — or the highlights of an important article — or a list of things that have to be done in perfect order!

Any one of them — they flash into **your** mind automatically, as though you pressed a button! **And this astonishing mental gift — which will serve you every day for the rest of your life — is yours from the very first hour that you pick up this book!**

And yet it's only the beginning!

Which Areas Of Your Mind Do You Want To Strengthen In A Single Weekend? Concentration, Will-Power, Self-Confidence, Habit-Breaking!

Yes! From this moment on, in less than one thrilling hour a day, you begin testing the wonder-working techniques of Automatic Organization on every untrained corner of your mind! You begin breaking through mental barriers—mental limitations that have been blocking you for years!

You begin tapping the buried powers of your own mind . . . powers that you have glimpsed before in brief flashes . . . now brought to the surface — organized with simple formulas to double their potency — and placed forever at your beck and call, ready to go to work for you at the blink of an eyelash!

For example —

DO YOU WANT TO DEVELOP "STEEL-SHUTTER CONCENTRATION" — OVERNIGHT?

Then turn to page 85 . . . master one simple exercise . . . and thrill to your ability to absorb huge amounts of information — easily and swiftly **— even in a room filled with half a dozen howling children!**

DO YOU WANT TO DEVELOP "X-RAY EYES" — POWERS OF OBSERVATION THAT AMAZE YOUR FRIENDS?

Then turn to page 136 . . . play three fascinating games . . . and then startle your friends, time and time again, by your ability to spot revealing details — put together hidden pieces of evidence — **that they never even dreamed were there at all!**

DO YOU WANT TO SEE HOW EASY IT IS TO REPLACE BAD HABITS WITH HABITS YOU CAN BE PROUD OF?

Then get ready for the revelation of your life on page 103 . . . that replaces agony with fun . . . **that acually lets your bad habits break themselves without your hardly touching your will power.**

YES! AND DO YOU WANT TO GENERATE ENTHUSIASM . . . FRIENDLINESS . . . PERSONALITY AT AN INSTANT COMMAND?

Then read every word starting on page 165! Learn how to overcome shyness and fear, automatically . . . make anyone like you . . . dissolve opposition with as little as a single word . . . earn both trust and respect from everyone you meet — **and keep them — for good!**

Read It For Thirty Days — Entirely At Our Risk!

And this still is just the beginning!

What Harry Lorayne has described to you on this page is just a small sampling of the information packed into his amazing new book, SECRETS OF MIND POWER — now available only through this article!

Here at last is a practical, fascinating, easy-to-read book on improving the powers of your mind **that really works!** Its author, Harry Lorayne, has been called by experts "the man with the most phenomenal memory in the

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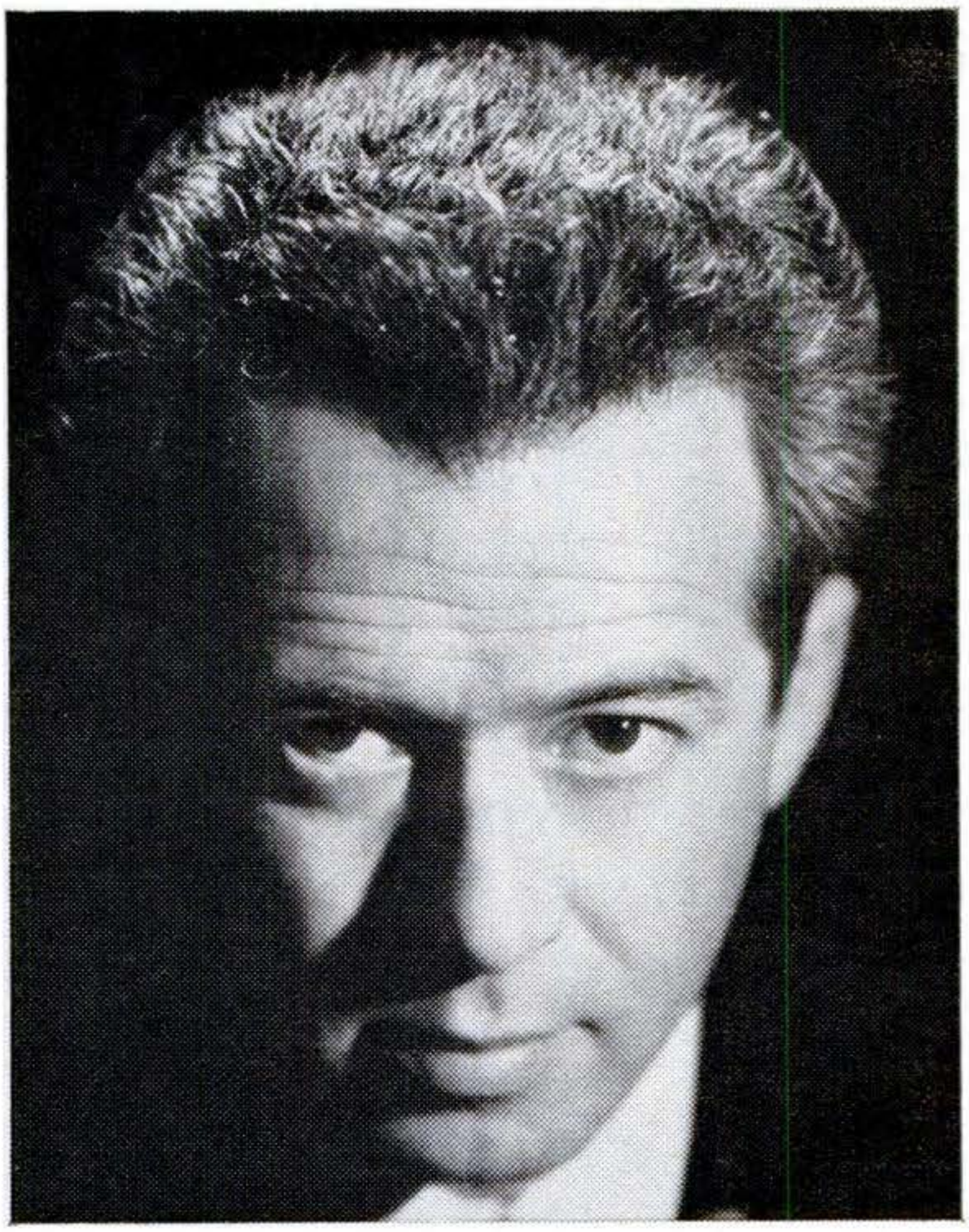
WIZARD IN ONE EVENING!



MEET HARRY LORAYNE

"The human being with the most phenomenal memory in the world." Harry Lorayne has lectured in front of thousands of Americans! Rotarians, Elks, Masons, Chamber of Commerce groups have all called on this amazing man to prove the business and social power of a Thinking-Machine Mind! Lorayne's mind is so well organized that he can remember the names, faces, addresses and occupations of over *700 different people in a single evening-after meeting each one of them only once!*

Mr. Lorayne's first book "HOW TO DEVELOP A SUPER-POWER MEMORY" has already shown over 250,000 men and women, all over America, how they can achieve startling improvements in their memory, overnight, with just a few minutes work. *But this fabulous Push-Button Memory Technique is only one small part of this great new work!* Now Harry Lorayne gives you secrets that powerfully strengthen EVERY AREA of your mind — Concentration, Will-Power, Problem-Solving, Idea-Creating, Rapid-Learning, Clear-Thinking, Worry-Control, and dozens more! *Secrets that work overnight! Secrets that can change your entire life in a single week — OR EVERY CENT OF YOUR MONEY BACK!*

Read the thrilling details on this page! Try this great work — ENTIRELY AT OUR RISK!

world!" He has already shown over 250,000 men and women, all over America, how they can **achieve startling improvements in their memories overnight, with just a few minutes work!**

But this fabulous Push-Button Memory Technique is only one small part of Harry Lorayne's great new book! Here — in addition to Memory — are complete "Push-Button Sections" on Observation, Concentration, Enthusiasm, Will-Power, Idea-Creating, Rapid-Learning, Time-Saving, Clear-Thinking, Personality, Friend-Making, Public-Speaking, Worry-Control, Conquest of Fear, and many more!

Yes! Here are dozens of simple techniques that enable you to overcome crippling emotions, and keep your thoughts headed straight for each goal! Showing you how to think clearly and effectively in any situation — make decisions without agonizing delays — learn vital facts and figures at a glance — work at full mental power, all day long, for weeks and even months on end!

Here are tested, and proven "Thought-Stimulators" that streamline your mind — develop your creative imagination — increase your daily output — help you make time for everything you have to do!

Here are "Confidence-Generators," that let you laugh off worries and fears — make your own good luck — keep other people from taking advantage of you — turn bad breaks into opportunities — yes, even sharpen your sense of humor and improve your ability to speak well, whether in private conversation or before a crowd of hundreds!

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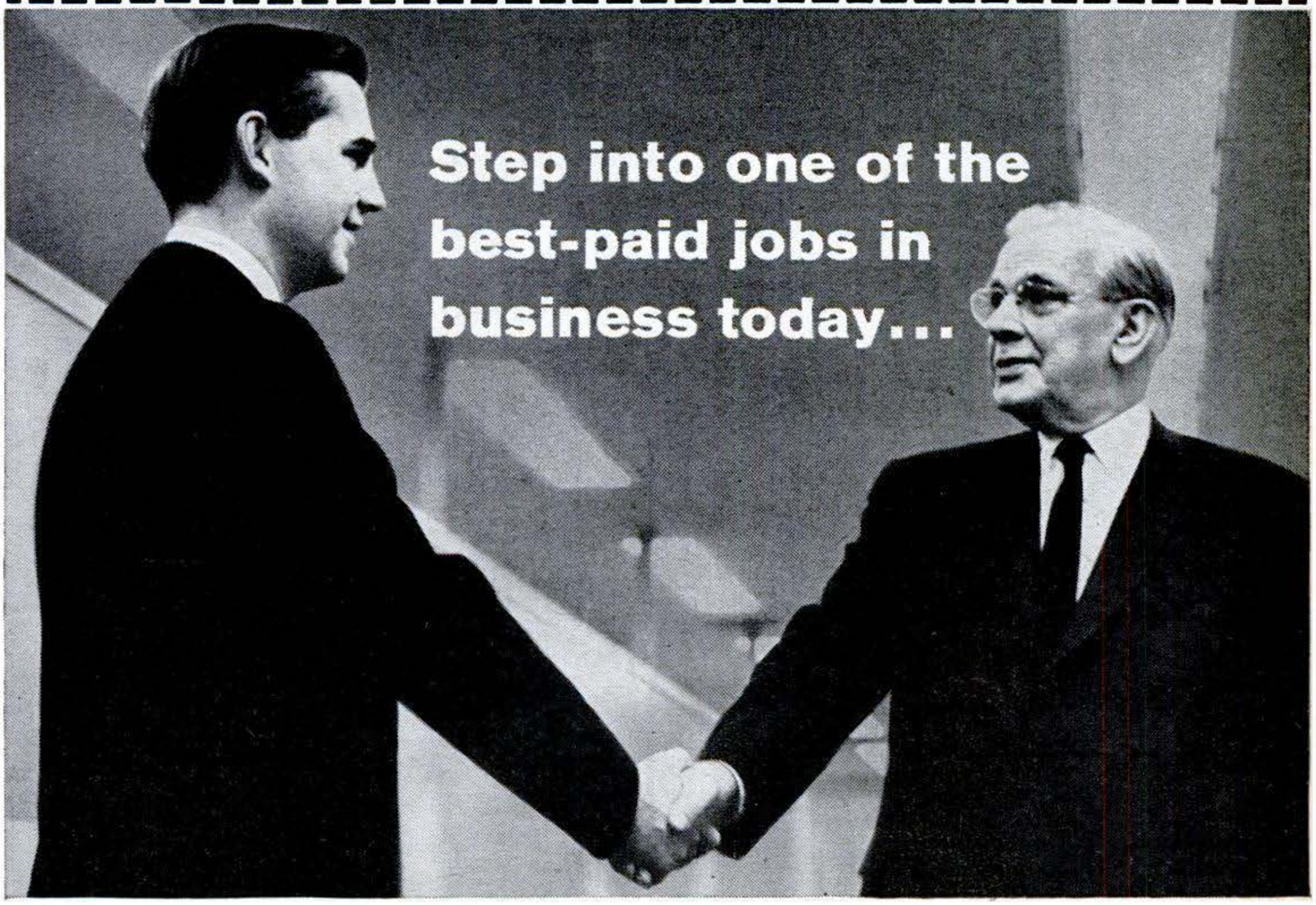

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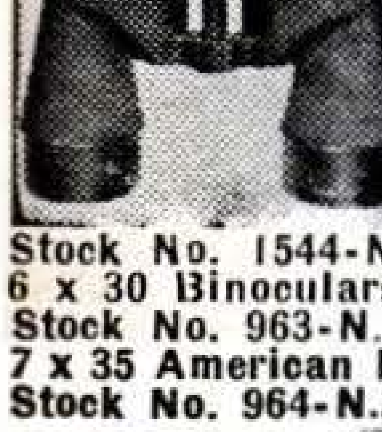

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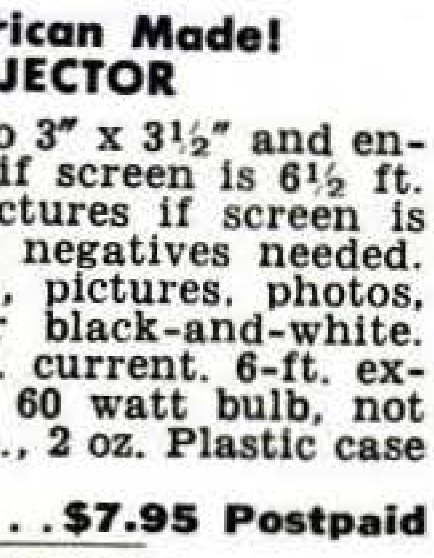

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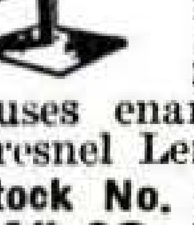

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Science newsfront

BY WALLACE CLOUD

A monthly report: What's going on in science and why it's important to you

MEDICINE

How a knockout hurts the brain

Body blows weaken a boxer, but it's the crashing right to the head that puts him out. Sometimes the knockout is permanent. The fighter who lives to be knocked out over and over again, on the other hand, stands a good chance of being punch-drunk after a few years. Despite heated controversy whenever there's a death in the ring, medical science has shed little light on the cause of the brain damage.

An English physician, Dr. F. B. Byrom of the University of London, suggests that a knockout punch spins the head so that the brain, cushioned in fluid, lags behind the rotation of the skull. This stretches the nerve fibers and veins at points where the brain is connected with the solid skull. Studies of the brains of victims of head injuries have shown torn brain tissues and bleeding that apparently result from such a swirling motion. Since damage to nerve fibers is never repaired by the body, Dr. Byrom feels that this explains the progressively worsening state of punch-drunkenness as well as the lethal one-time injury.

The successful boxer, he says, learns that the more rigidly he can hold his head, the less he will react to blows to the head—which is why Jack Dempsey used a cannon ball on a loop of rope to strengthen his neck muscles. Considering whether brain damage can be prevented, Dr. Byrom concludes that padded gloves protect the fingers more than the brain. A head guard may aggravate the damage if it increases the leverage of a blow by adding to the radius of the head. He doubts that boxing could survive a rule barring blows above the collarbone.

PHYSICS

A game of hide and seek

For some years now, nuclear physicists have been in the position of a man who has accidentally spilled all the change out of his pocket. Knowing whether you've picked up the last penny depends on knowing how much money you had to start with.

When the physicists began bombarding the nucleus of the atom with particle beams from more and more powerful accelerators, all sorts of unexpected particles began spilling out. A lot of chalk and blackboard erasers were used up before they figured out that there ought to be exactly 34. Meanwhile, they were searching for the kinds of particles predicted by their equations, ticking them off one by one.

A muted fanfare of trumpets, please: 13 experimenters from Yale and the Brookhaven National Laboratory have found the 34th particle. It's called the anti-Xi-zero.

Anti means it's a particle of antimatter, the strange mirror image of matter, which annihilates matter and is itself annihilated when the two meet. Of the 34 predicted particles, 17 are actually matter and the

CONTINUED

For deep space navigation, the Martin Company has developed a "trisextant," here being demonstrated by Donald H. Novak, one of the engineers who designed it. An ordinary sextant isn't adequate, since the space navigator must sight three reference points simultaneously, rather than the two points used on earth. Martin says the trisextant will enable an astronaut to calculate his position with pencil and paper, eliminating the need for a computer.

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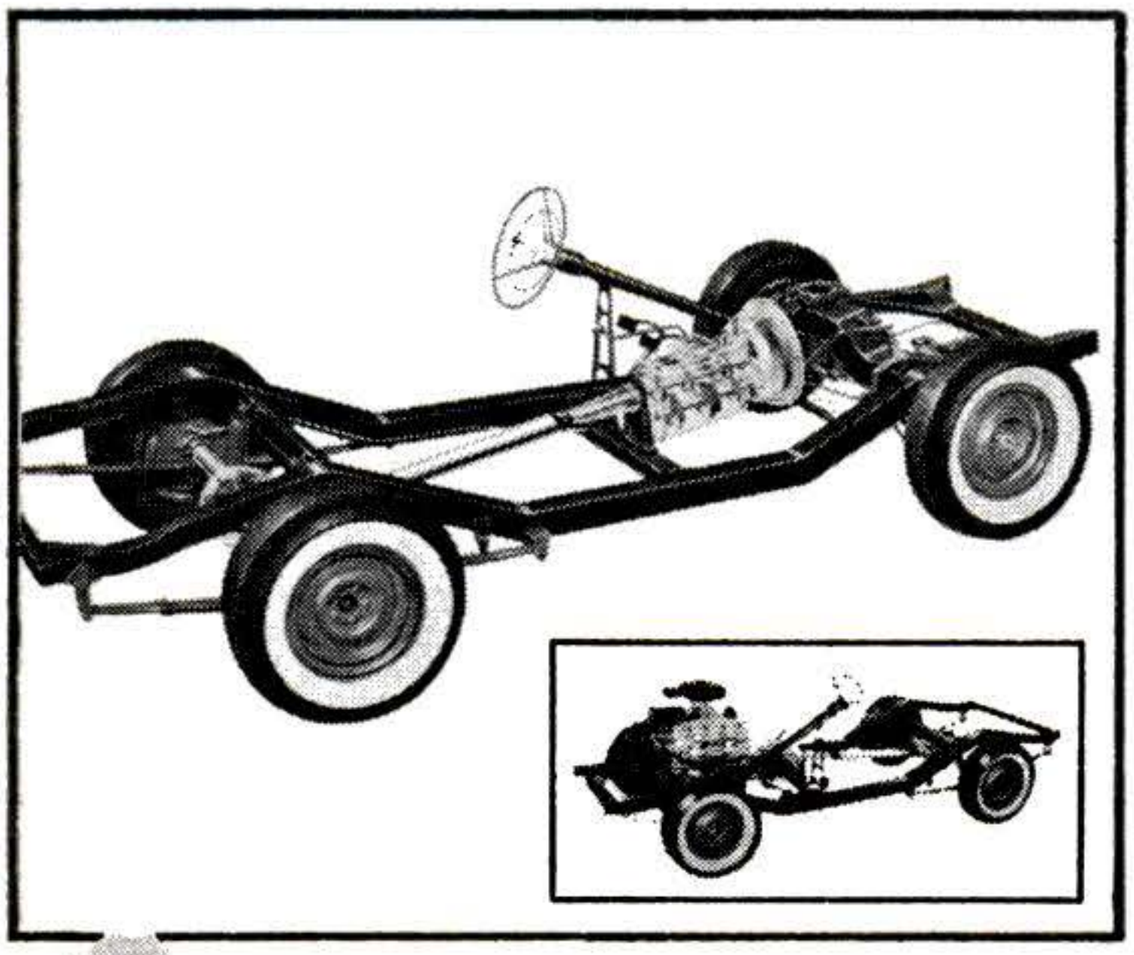
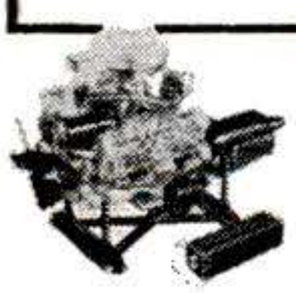
EVEN A MASTER MECHANIC COULD LEARN A THING OR TWO

by building these amazing "Visible" hobby kits.





You probably know the Renwal Visible V-8, the most accurately detailed ¼ scale automotive engine kit ever produced. Now, Renwal introduces the VISIBLE CHASSIS, over three feet long, with the same superb engineering that made the Visible V-8 a hobbyist's favorite. Everything works: Shift and watch the gears slide into position. Turn the wheel, and learn how the steering system and suspension operate. No detail was omitted. And thanks to Renwal's famous "Visible" construction, you see the "inside story." The Visible Chassis comes complete with battery driven motor, and parts for installation of the Visible V-8. By itself, the Visible Chassis is an amazingly realistic hobby kit. With the Visible V-8, it's a complete automotive education. Visible Chassis $19.95, Visible V-8 $10.95, Chassis and V-8 Set $29.95.

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Science newsfront continued

other 17 are their counterpart antiparticles.

Using Brookhaven's 30-billion electron-volt Alternating Gradient Synchrotron, the team of researchers found the anti-Xi-zero by directing a beam of anti-protons into a tank of liquid hydrogen, to collide with the protons in the hydrogen. Among other things, these collisions released anti-Xi-zero particles—revealed by analysis of bubble tracks in the liquid hydrogen.

A sigh of relief has now passed through the world of nuclear physics—at long last,

Volunteers for space. NASA has announced how many and what kind of people responded to their call for applications for astronaut training last spring: Air Force, 26; Navy, 34; Marines, 10; Army, 1; and civilians, 200. Screening of applicants is now under way.

no more of that bothersome hunting for pesky particles. All that is left is to explain *why* there are 34 fundamental particles. But a whisper of dissent is also heard: Can we really be sure there are only 34?

And some physicists say 34 is too many. Dr. Victor F. Weisskopf, director-general of the European nuclear-research center at Geneva, says there are only two basic particles. These are the baryon and the lepton —collective names that have been applied to groups of particles for several years. These two particles, he says, put on the 34 masks that confuse other physicists.

To probe this perplexing basis of our physical world more deeply, a panel of U.S. scientists recently recommended construction of a 100-trillion electron-volt accelerator that would cost 100 billion dollars. Such dreams would be material for the psychiatrists in a world that didn't know the atom bomb.

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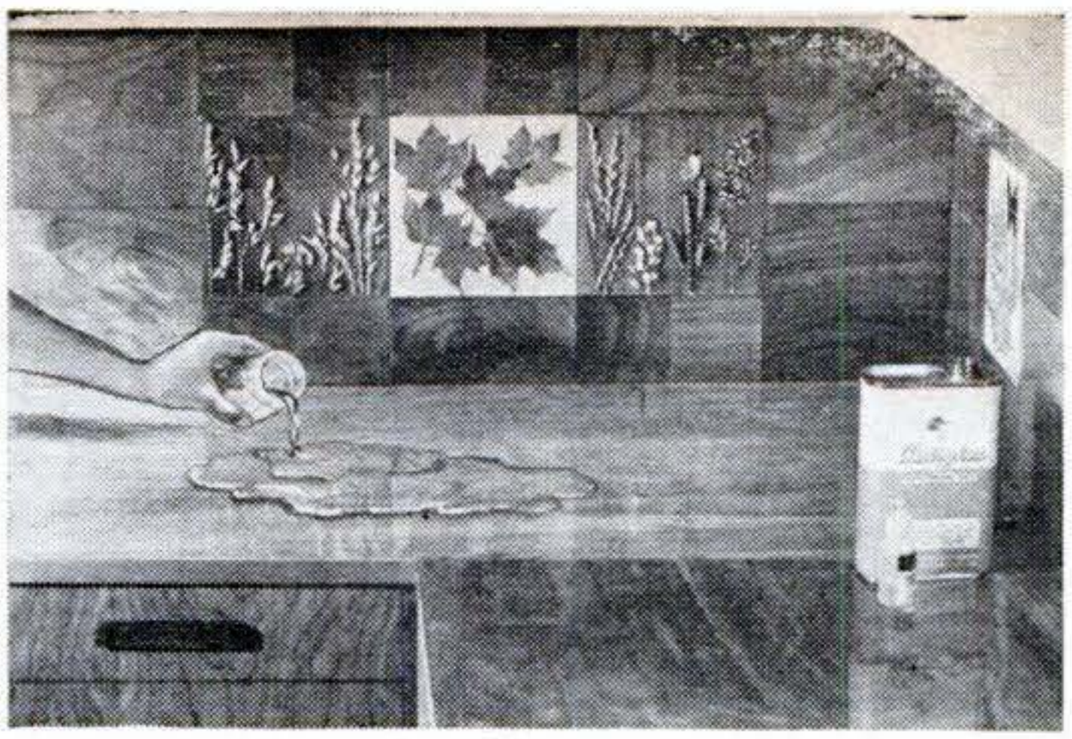

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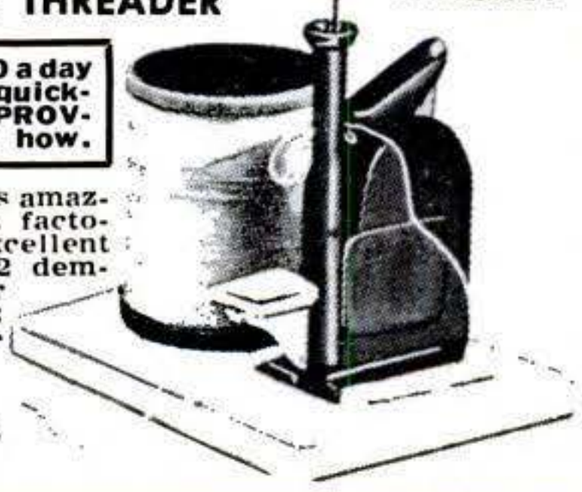

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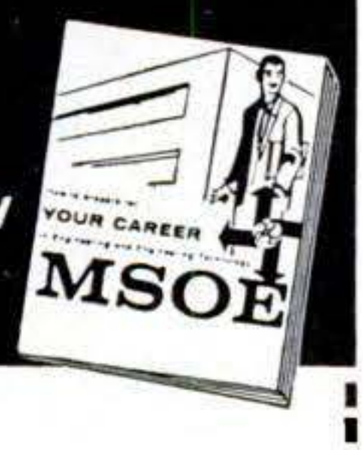

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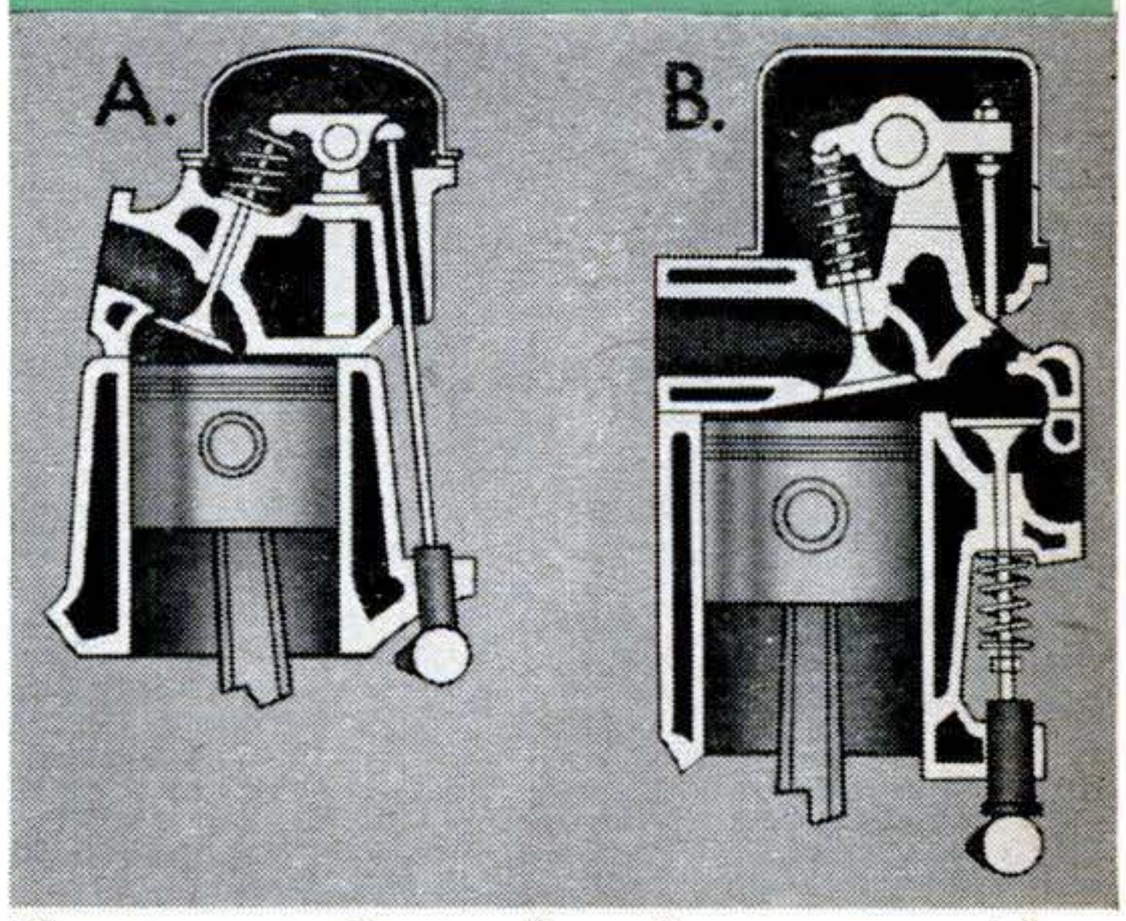

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The hide industry is preparing to counterattack with advertising extolling leather. But their ace-in-the-hole is an experimental process for dissolving leather and then reconstituting it into sheets of uniform quality. Trouble is, under U.S. labeling laws they may not be able to call it leather.

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COED—Computer Operated Electronic Display.

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HAAW—Heavy Antitank Assault Weapon.

LARC—Lybian-American Reconstruction Commission.

PIPER—Pulsed Intense Plasma for Exploratory Research.

And so forth. These are excerpted from ABRACADABRA, which is an acronym for ABbreviations and Related ACronyms Associated with Defense, Astronautics, Business, and RAdio-electronics, a little booklet put out by the Raytheon Company. Anyone can get a free copy by writing the Office of Public Relations, Dept. PS, Raytheon Company, Lexington 73, Mass. ■■

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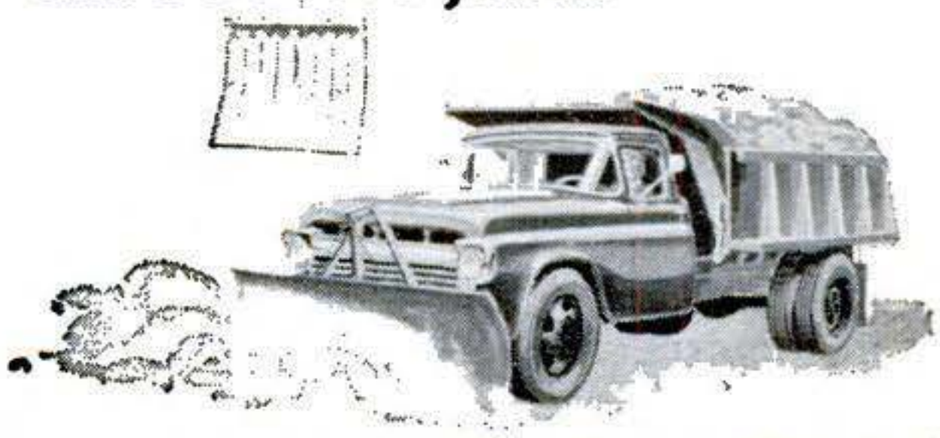

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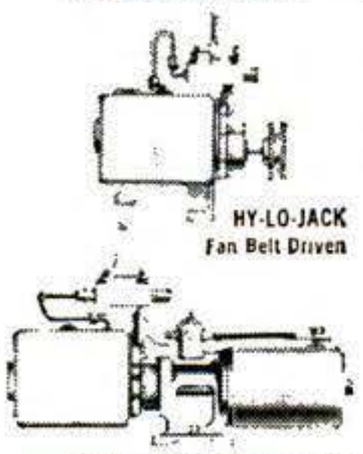

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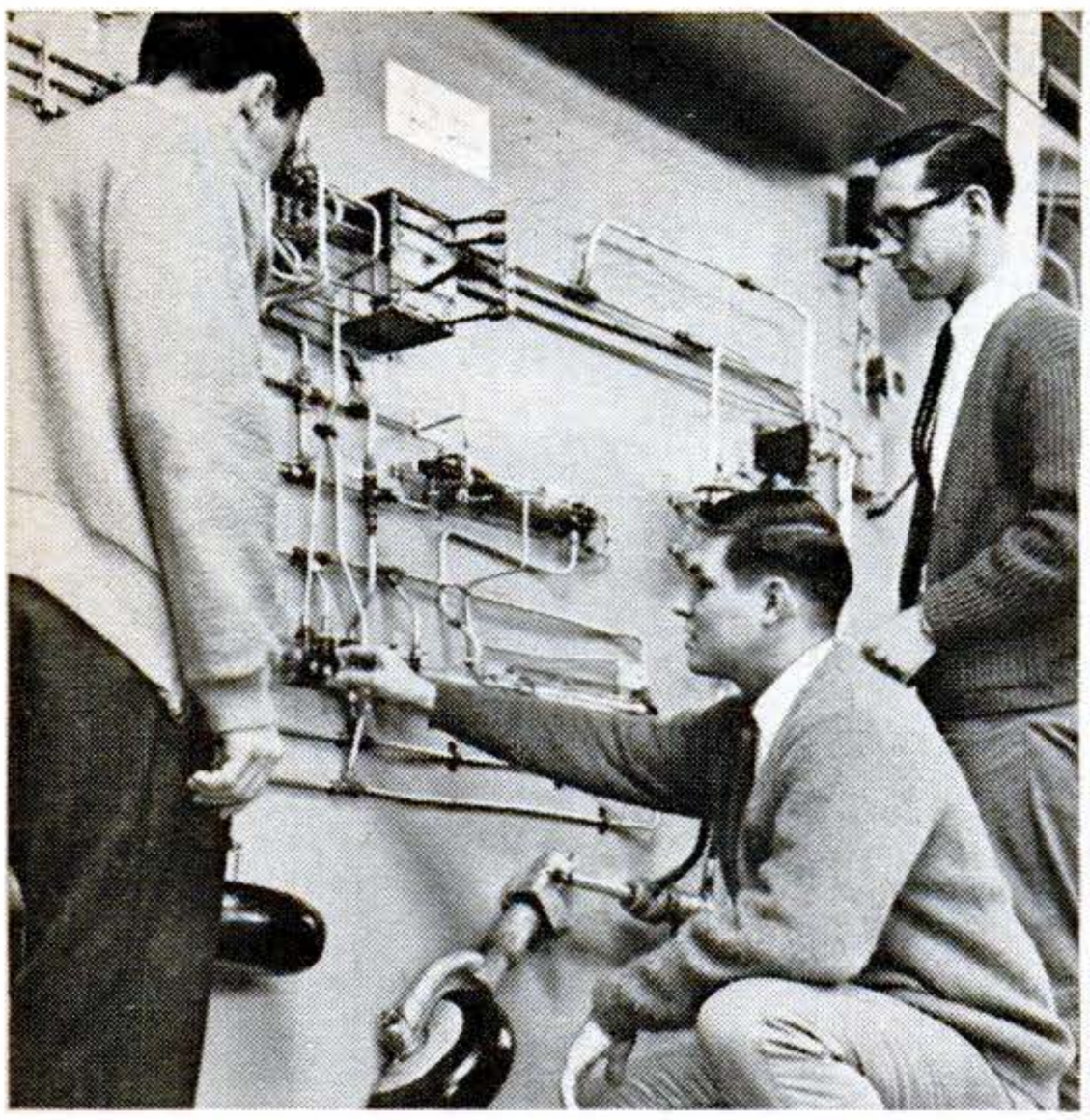

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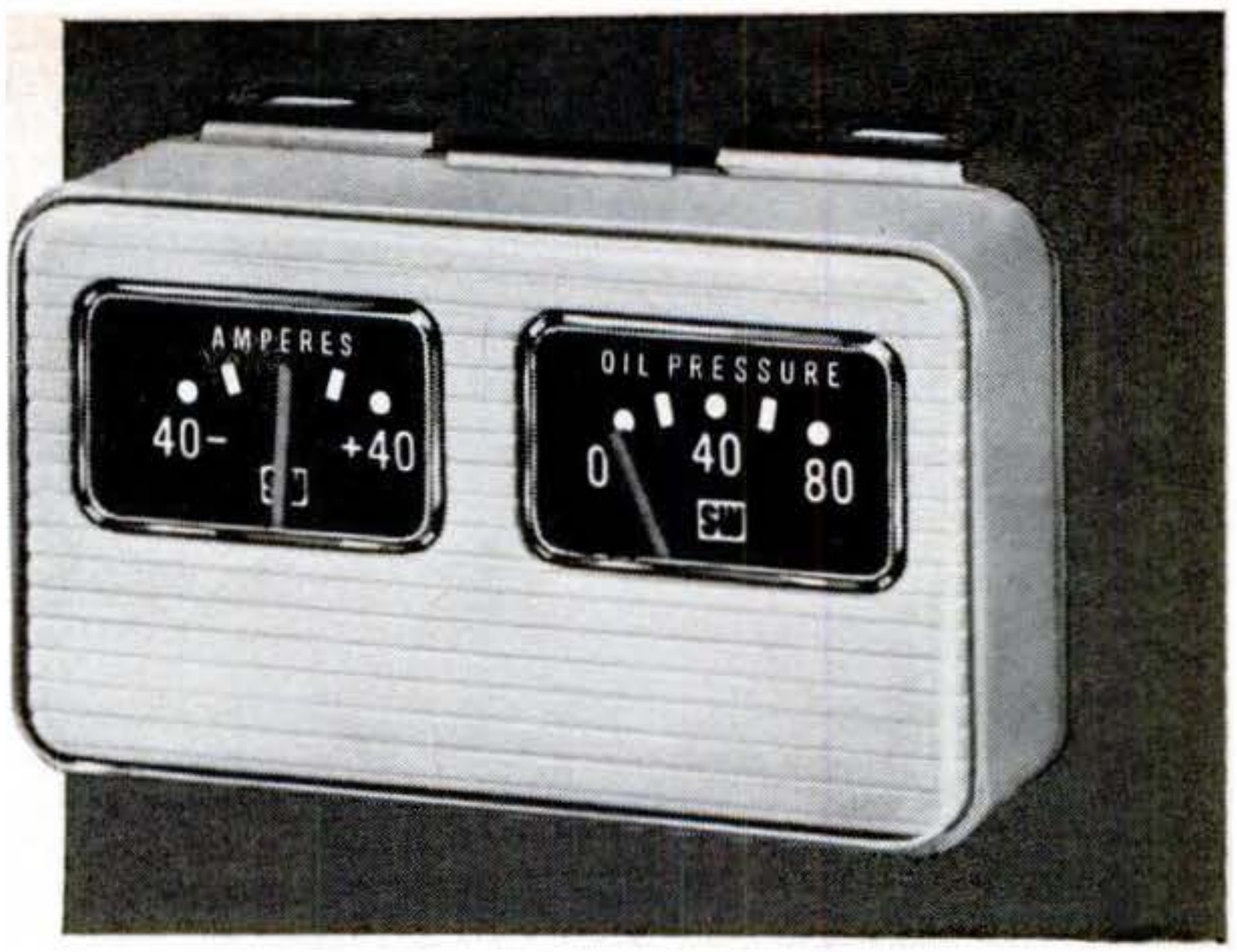

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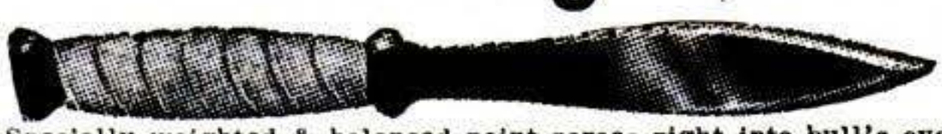

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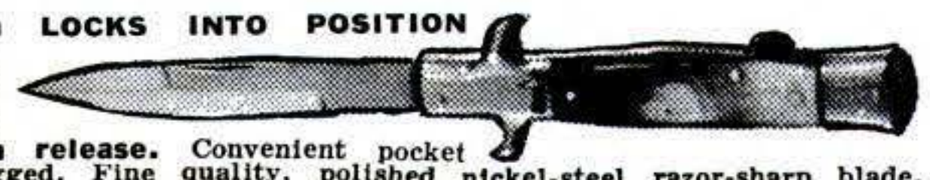

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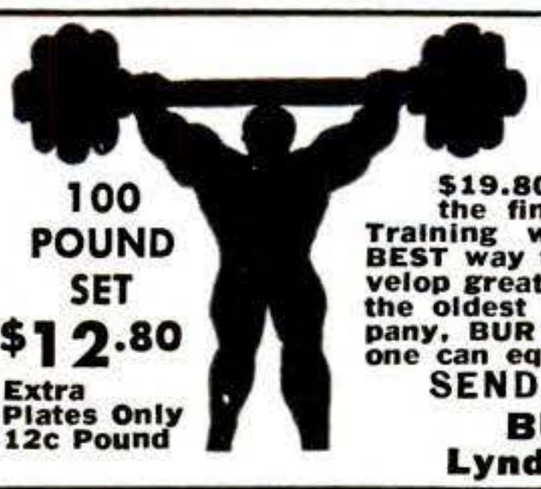

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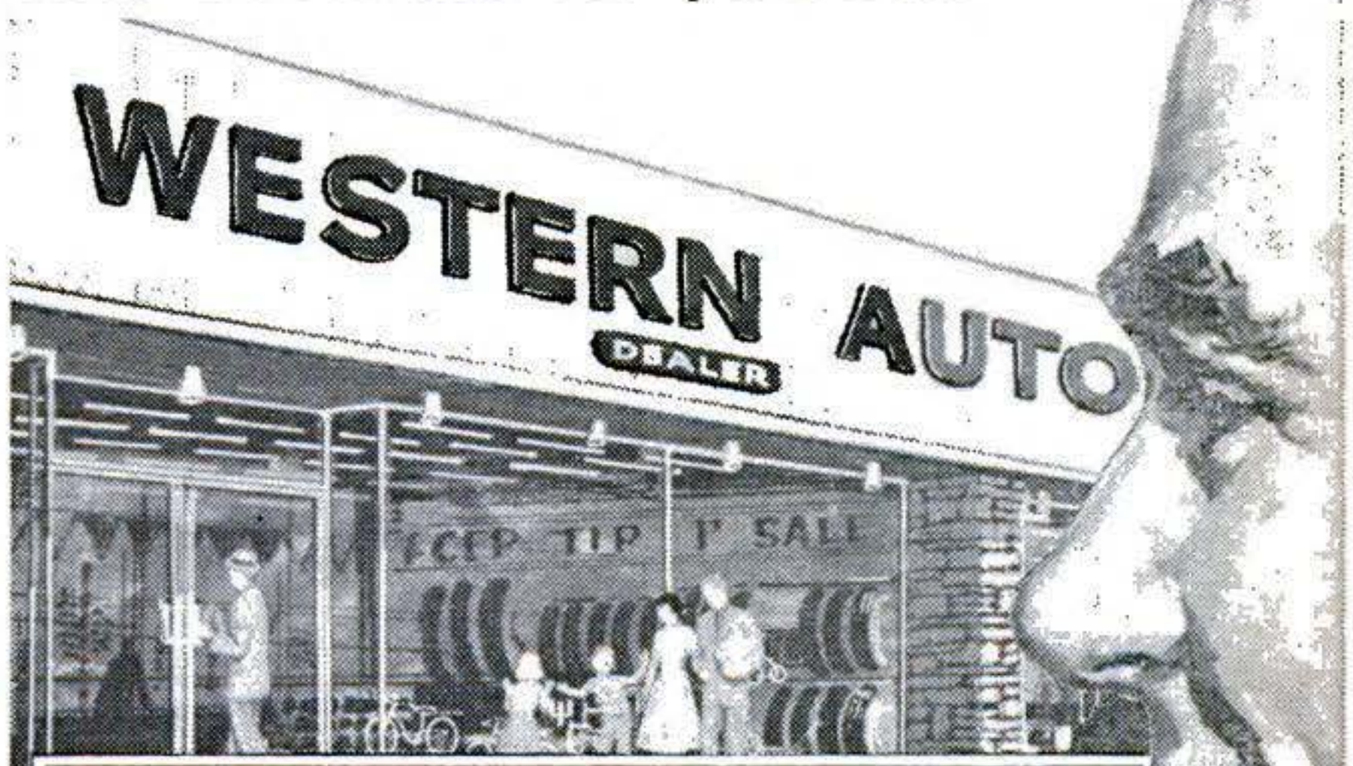

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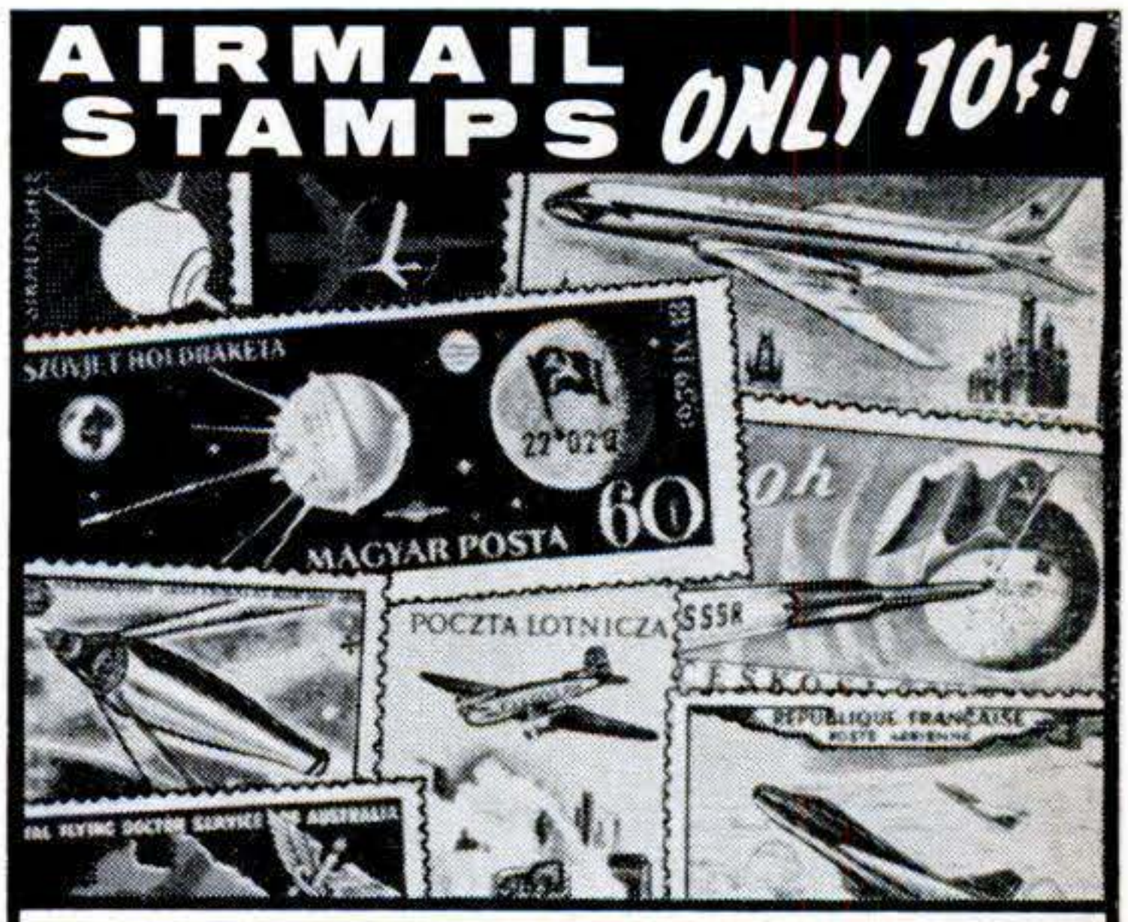

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Getting Ahead

By Dr. Lewis R. Fibel

A monthly column to help you prepare yourself for a better job

They say:

U. S. Department of Labor: "The job outlook is good for 1963 college graduates. Employment opportunities will be more plentiful than last year and beginning salaries will average three to five percent more."

National Opinion Research Center: "The impact of adult education on American life is rising. One out of five adults—25,000,000 persons—follows some plan for leisure-time education."

Bureau of Applied Social Research: "The number of professional, technical, and kindred workers grew by 2,400,000 persons in the 1950s. It also grew as a proportion of the total labor force."

U. S. Commissioner of Education, Francis Keppel: "It is a national shame that 23,000,000 Americans over 18 have completed only eight years of schooling."

"I will be discharged from the Air Force in January, 1964. I want to go to college and earn a B.S. in engineering. Can I get a loan from the government?"—D.L.B., Romney, Ind.

The National Defense Student Loan Program is intended "to stimulate and assist in the establishment at institutions of higher education of funds for the making of low-interest loans to students in need." The act specifies that "in the selection of students, special consideration shall be given to . . . students whose academic background indicates a superior capacity or preparation in science, mathematics, engineering, or a modern foreign language."

In order to be eligible, an applicant must be a full-time college student in an institution participating in the NDSL program, or *be accepted for admission* as a full-time student. He must be in good standing and capable of maintaining such standing. Most accredited engineering colleges participate in the loan program.

You should (1) apply to and be accepted by an engineering college; (2) apply there for an NDSL loan.

"Are there any correspondence courses available in building maintenance and management?"—W.D.R., Calais, Me.

I can't find any. Perhaps some reader can help. There are some public vocational schools that offer courses that might be of interest. Let me know if you want their names.

"How can I get into the field of space medicine?"—A.L., Philadelphia, Pa.

"Space medicine" usually means the study of the physiological and psychological behavior of humans traveling in spacecraft or in the environs of the moon or the planets. One purpose is to develop devices that will ensure health and life under these conditions.

The research is usually done by teams of scientists, engineers, and aides. A typical team might include:

Group leader: specially trained physician (M.D.)
Senior scientist: physiologist (Ph.D.)
Senior engineer: electronics engineer (M.S.)
Junior scientist: biochemist (M.S.)
Junior scientist: young M.D.
2-3 electronics technicians.
2-3 instrument technicians.
2-3 laboratory technicians.
(The technicians would have, on the average, two years of college education.)

So there are many avenues to this career. It's up to you to decide the role that best suits your interests and talents.

"I'd like to become an actuary. Are there any special math courses I should take in college? How much would I earn, and what are the chances for advancement?" —R.C.N., Easthampton, Mass.

Actuaries are mathematicians whose main job is to keep insurance plans on a sound financial basis. Starting salaries of new

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47892 x 39421 = ?

AS EASY AS 1 + 1 = 2

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This man is multiplying numbers that should ordinarily produce the answer in about 4 minutes. The answer appears on his blackboard in less than 15 seconds flat! Yet he knows little about math! As a matter of fact he failed arithmetic in school. Read on to discover the fantastic new method that even a child can learn easily in just a few short hours — at home . . .

Yes, in just hours you can turn into a "math wizard" even though you know little about arithmetic! Surprise your friends with your "E-Z MATH" ability . . . enjoy job security and advancement . . . a better job . . . Increase your self-confidence and prestige—all through amazing new "E-Z MATH".

The world is moving *fast* these days. In good times and bad the ability to handle mathematical problems in our age of electronics, automation and nuclear science is becoming more and more necessary for promotion on the job and for higher pay. If you don't think you have what it takes—and if you believe that "math" is beyond your power—then you're in for the biggest surprise of your life!

For now you CAN learn to DIVIDE, MULTIPLY, ADD and SUBTRACT figures not only *quickly* and *easily*—but also in a FRACTION of the time the average person requires! You can actually solve such tough problems as multiplying a 5-figure number by a 7-figure number in your head without ever touching pencil to paper . . . or dividing 836791 by 284, for example, in exactly 15 seconds—even if you "flunked" math in school!

The secret of success in "math" is NOT laborious study and wearisome practice—but, on the contrary, knowledge of SPECIAL SHORT CUTS, LITTLE-KNOWN METHODS of calculation and arithmetical "tricks" that take the work and gamble out of figuring. These methods—so new and radical that they have not yet been incorporated in our school systems—take but a few hours to learn. Yet they permit you to OUT-THINK and OUT-FIGURE the average high school and college graduate who hasn't had the benefit of these amazing methods! You can even BEAT AN ELECTRIC CALCULATOR in answering many problems!

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"E-Z MATH" shows you in plain, easy-to-understand language how to cut figuring time in HALF and even in QUARTERS—and at the same time arrive at the *correct* answer in every case! The methods and short cuts you learn in "E-Z MATH" are *foolproof* . . . require almost NO memorization . . . and are so *practical* that you'll find yourself using these systems virtually every day. You'll become an expert in no time at all. Before you know it—you're ready to move into that important job you've always wanted . . . to drive ahead and in greater responsibility at higher pay . . . and to amaze, surprise and delight your friends with your new magic powers of mental arithmetic! Yes, "math" will open up new opportunities for you, since the person with "math" know-how can just about "write his own ticket."

Sharpen Your Brain Power—with Short-Cut "E-Z MATH"!

Imagine being asked to divide 38634 by 89½—and rattling off the answer absolutely correctly in 7 seconds! Or—multiplying 369.34 by 982.7 and coming up with the correct result in 11 seconds! Or adding 29 numbers each with 6 digits—and supplying the right total every time! People will GASP at your fabulous lightning-quick mind. You'll be able to JUGGLE numbers . . . do STUNNING TRICKS . . . amaze your friends and boss—and be a "master mind!"

With a knowledge of "E-Z MATH" you no longer need be puzzled by such every-day figuring as computing interest charges on installment purchases . . . division, multiplication and addition of fractions . . . adding long rows of numbers with 100% accuracy . . . adding and subtracting fractions from whole numbers—plus many, many other practical and valuable pointers you will use daily to your advantage. The few hours you spend with this course will really pay off. Numbers are the basic instrument of all scientific and technical work. The man or woman who can use "math" is rewarded, recognized quickly, moves *ahead* in his job faster and more surely!

Order Today on No-Risk Free Home Trial!

Send for "E-Z MATH" today on our no-risk money-back guarantee: use the book for 30 days . . . prove to your own satisfaction how far a knowledge of "E-Z MATH" can advance you in business and social life. If you don't agree that this is the *best investment* you've ever made . . . if your family and friends aren't AMAZED by your new ability—return the book for full and prompt refund.

CAN YOU SOLVE THESE EVERY-DAY BUSINESS AND SOCIAL ARITHMETIC PROBLEMS IN THE TIME ALLOWED? YOU CAN DO THEM EASILY EVEN WHEN BLINDFOLDED—AFTER YOU'VE READ "E-Z MATH"!

Blindfold yourself and have someone call the following numbers to you as you add them:

739
463
906
785
642

(Solve in 6 seconds) ?

$\frac{9864372}{8146}$ = ? (Solve in 9 seconds)

$\frac{4}{7} \times \frac{9}{4}$ = ? (Solve in 4 seconds)

1¾% interest per month amounts to what percentage yearly? (Solve in 4 seconds)

367 X 75 = ? (Solve in 3 seconds)

WHAT IS "E-Z MATH"?

"E-Z MATH" is based on an amazing new method of working with numbers—easier to learn and remarkably faster and more accurate than you ever dreamed possible when you took math in school. You'll be shown the newest way of *reading* numbers—just as though they were *words*—and of adding and subtracting them almost at a glance—INSTANTLY! You'll be shown a unique new technique for adding hundreds and even thousands of numbers without ever making a mistake . . . yet you'll never add higher than eleven! Yes, from now on you'll whiz through all figuring problems without wasting your valuable time—through income tax, checking grocery lists, homework—as fast as a calculator. You'll never again dislike or avoid numbers—you'll actually ENJOY using them to get ahead in business!

WHAT THEY SAY:

"My 10-year old had nearly always failed arithmetic with old-method arithmetic. Then he found my copy of 'E-Z MATH'. Now in less time than you can put the numbers on a blackboard, he can multiply 8391726547 by 12. It's amazing and incredibly easy. I use it myself on my job and my wife uses it to check grocery lists."

A Father

"You have a unique new teaching approach for which I compliment you. It's the best I have ever seen. Pupils' marks seem to be climbing as a result. Should help in any job. Excellent for home tutoring use."

—SCHOOL PRINCIPAL

"Thank you! Thank you! Thank you! All our children are using your system too, and it is terrific. My husband and I are using it—and it works! My husband has already received a job advancement with tremendous boost in pay. Best investment we have ever made!"

-HOUSEWIFE

"My employee, Joe Malone, asked for a better job. I recommended he read 'E-Z MATH'. Now that he can do 'tough' problems easily, I've promoted him to head of his department with a $35. weekly increase in pay. I now suggest all employees read 'E-Z MATH' if they want to get ahead in their jobs."

Business Executive

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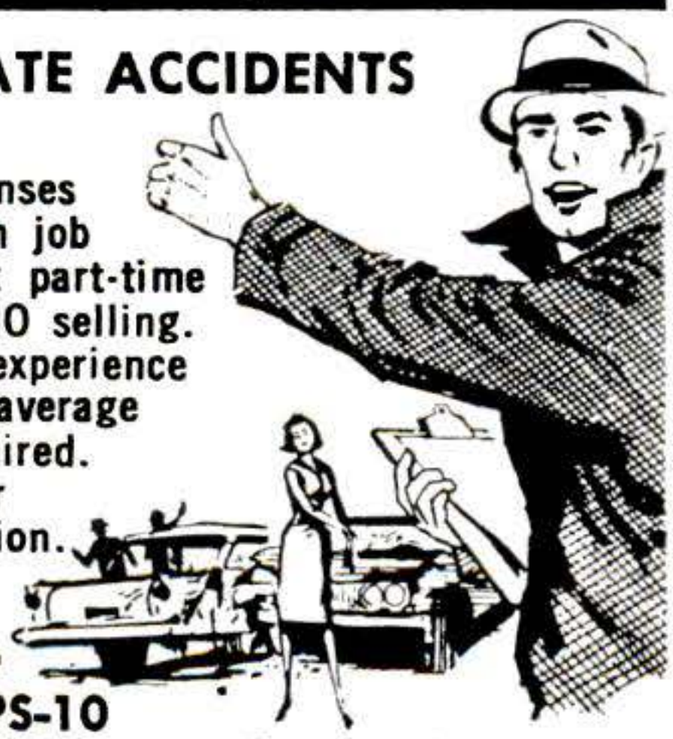

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Getting Ahead continued

college graduates hired as actuaries were generally between $5,000 and $5,500 a year in 1960 (latest figures available). Those who had passed some of the preliminary actuarial examinations given by the professional societies usually got considerably higher starting pay. Annual salaries of $25,000 and more may be earned by actuaries in executive positions in large companies. A brochure describing the profession can be obtained (45 cents) by writing to Science Research Associates, 57 West Grand Ave., Chicago 10.

A bachelor's degree in mathematics is generally required for entry into actuarial work. Undergraduate training should include differential and integral calculus, analytical geometry, mathematical statistics, probability, and finite differences, as well as courses in insurance law, economics, investments, and accounting. A well-rounded education and the ability to deal with people and to express oneself clearly and simply are important, for the man who wants to get to the top.

"What is the outlook in the field of technical writing for a man of 47 with an above-average vocabulary? Could you recommend any correspondence courses?"—J.I.A., Trimountain, Mich.

Technical writers work closely with engineers, particularly in plants making military and industrial products and in research-and-development firms. They might prepare training and technical manuals describing the operation and maintenance of electronic equipment, for example. Or they might write product literature, or prepare project reports and proposals.

They should have a flair for writing, as well as some technical training. Electronics firms prefer people who have had some courses in a technical institute or college. Many writers have college degrees in English or journalism.

The following correspondence schools offer training in writing, which in some cases includes technical writing:

American School, 850 East 58th St., Chicago 36.

Famous Writers School, Westport, Conn.

International Correspondence Schools, Scranton 15, Pa.

Many schools offer the technical training

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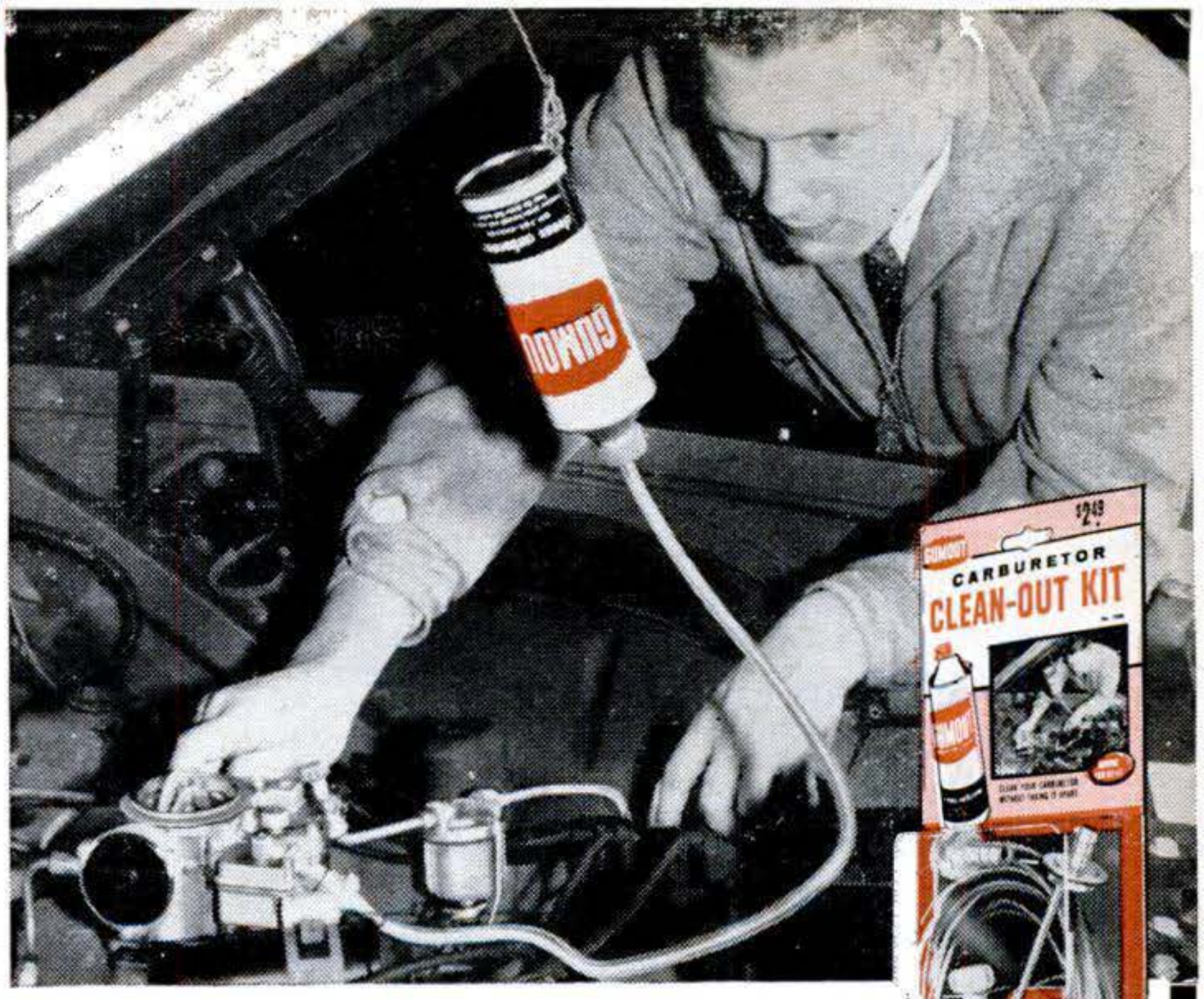

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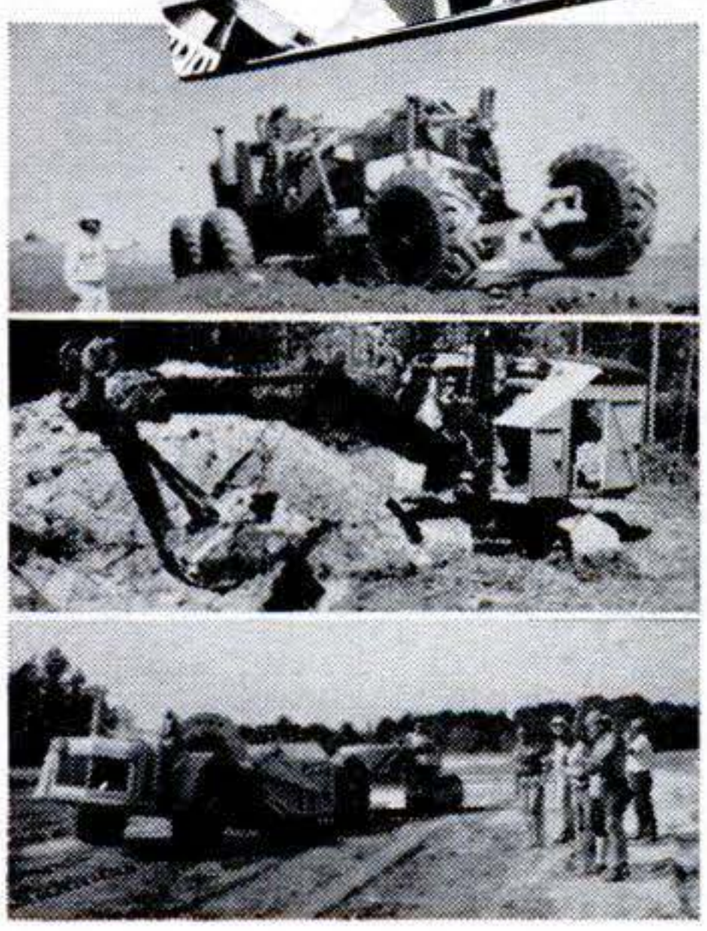

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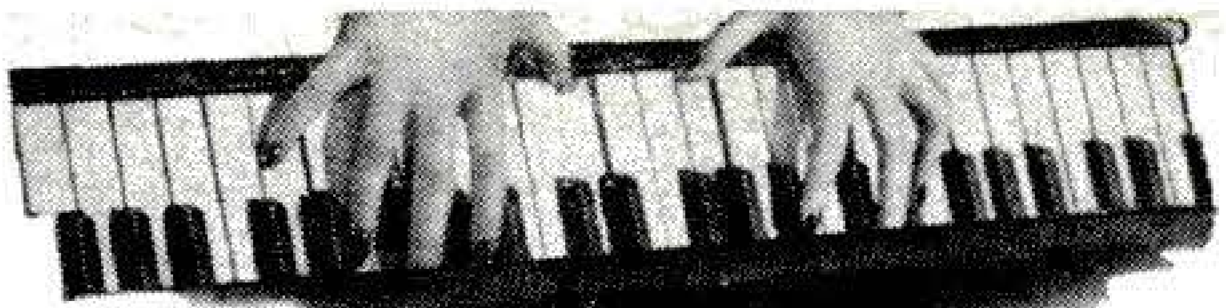

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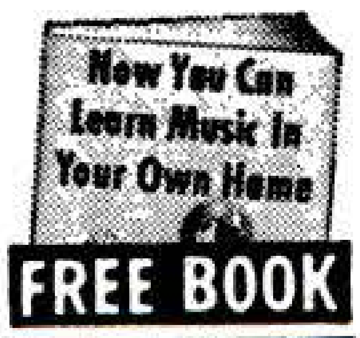

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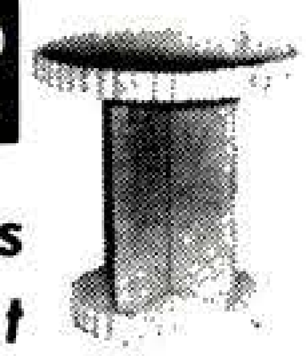

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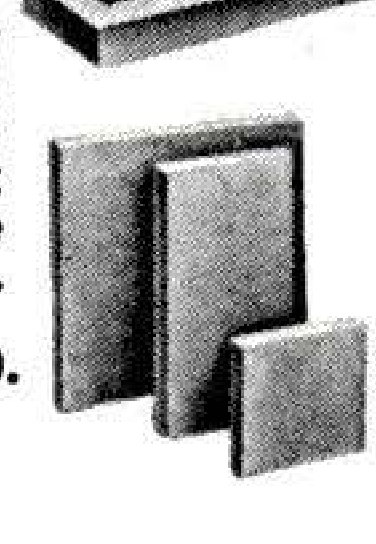

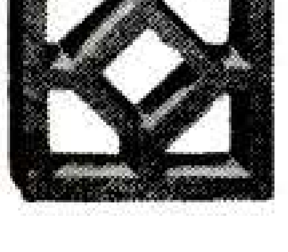

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DeVry Technical Institute, 4141 Belmont Ave., Chicago 41.

National Radio Institute, 3939 Wisconsin Ave. N.W., Washington 16, D.C.

"I am interested in photography, especially photojournalism and newspaper photography. I don't have the money for school. Could the Navy help me?"—J.H., Asheville, N.C.

All the armed forces use photographers, and all have excellent training schools. The education and experience that you could gain in this manner would be of great value to you in civilian life. You can get general information on occupations in the armed forces from your local recruiting stations. You should also get information about special enlistment programs. Write to: "It's Your Choice," Washington 25, D.C., for a good general pamphlet on this.

"What do you have to do to become a policeman?"—T.B., Milwaukee, Wis.

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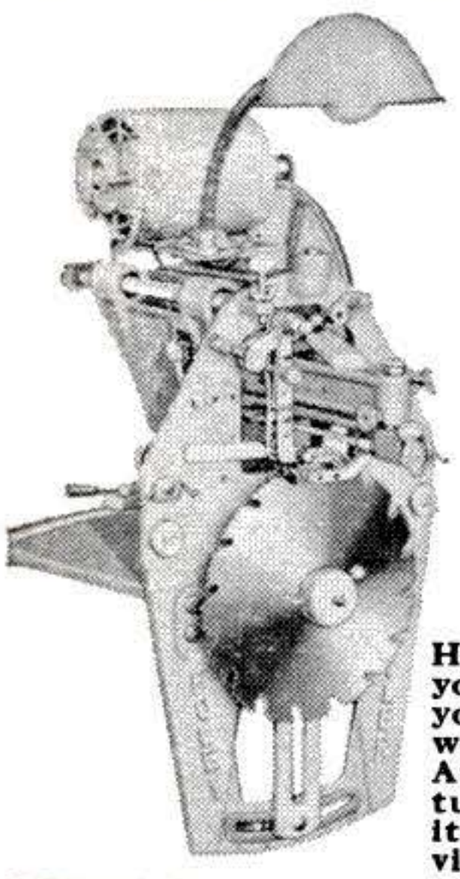

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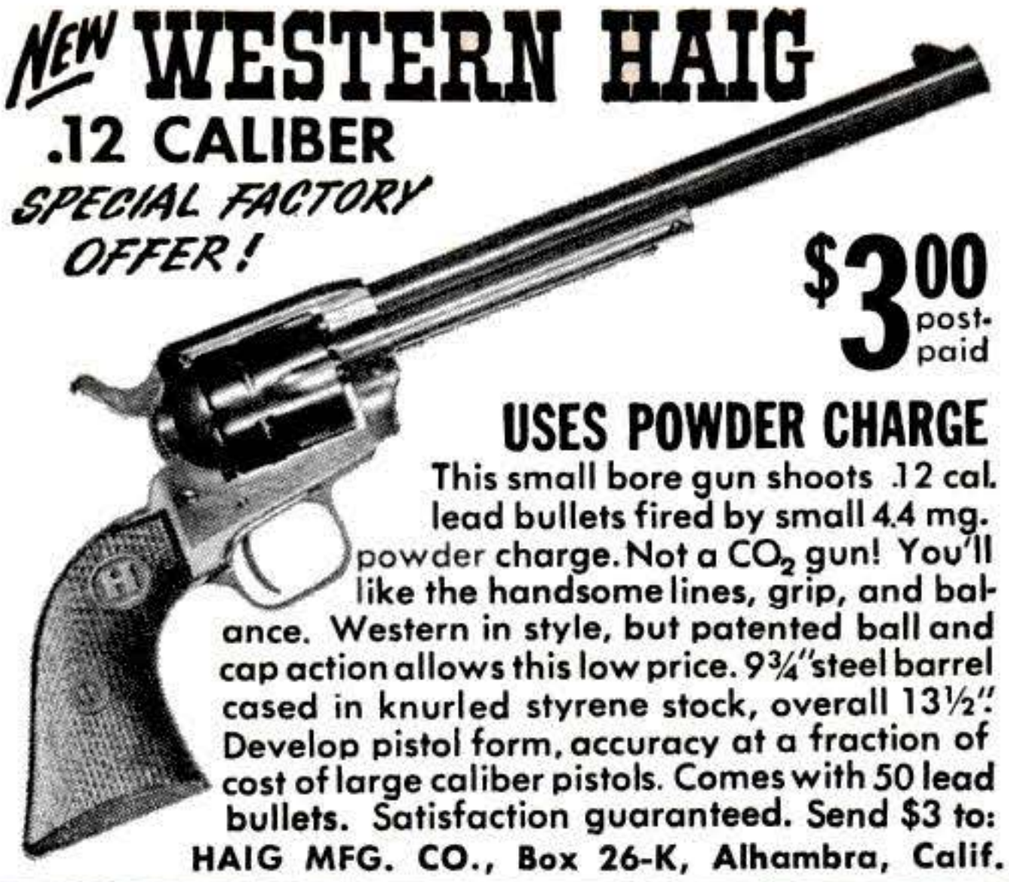

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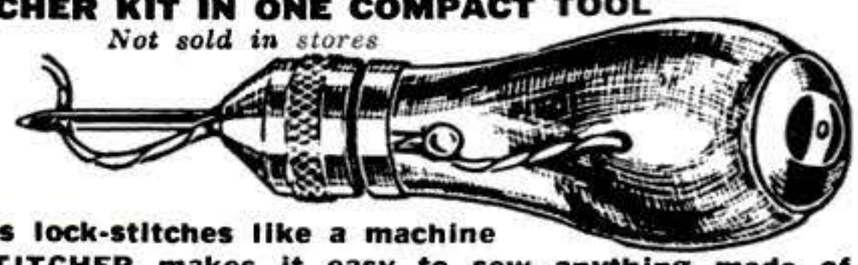

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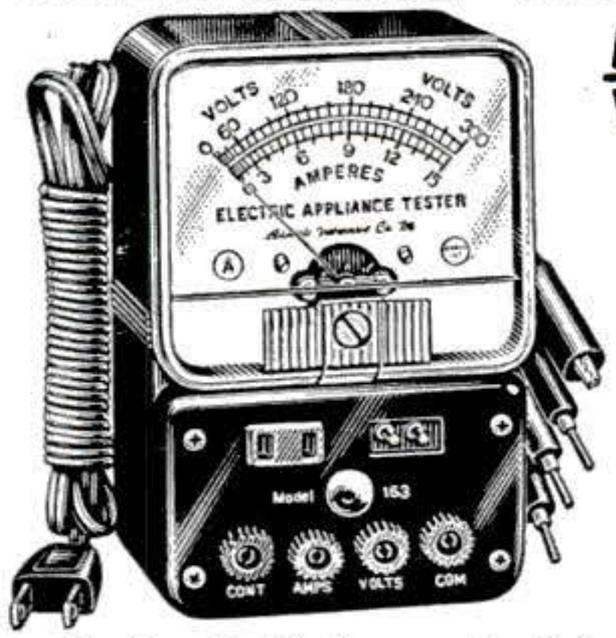

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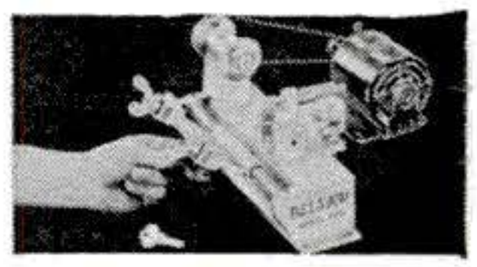

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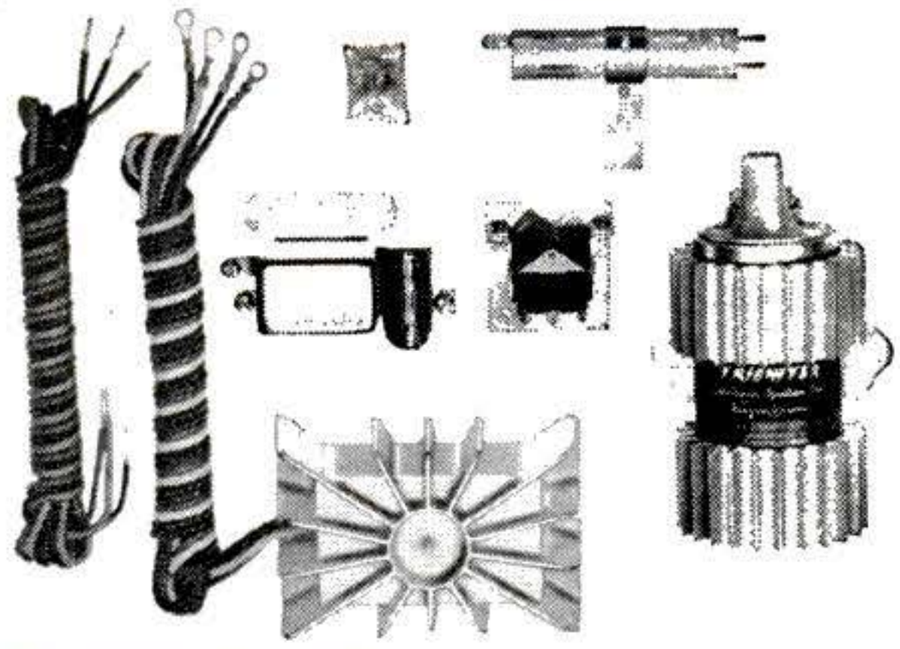

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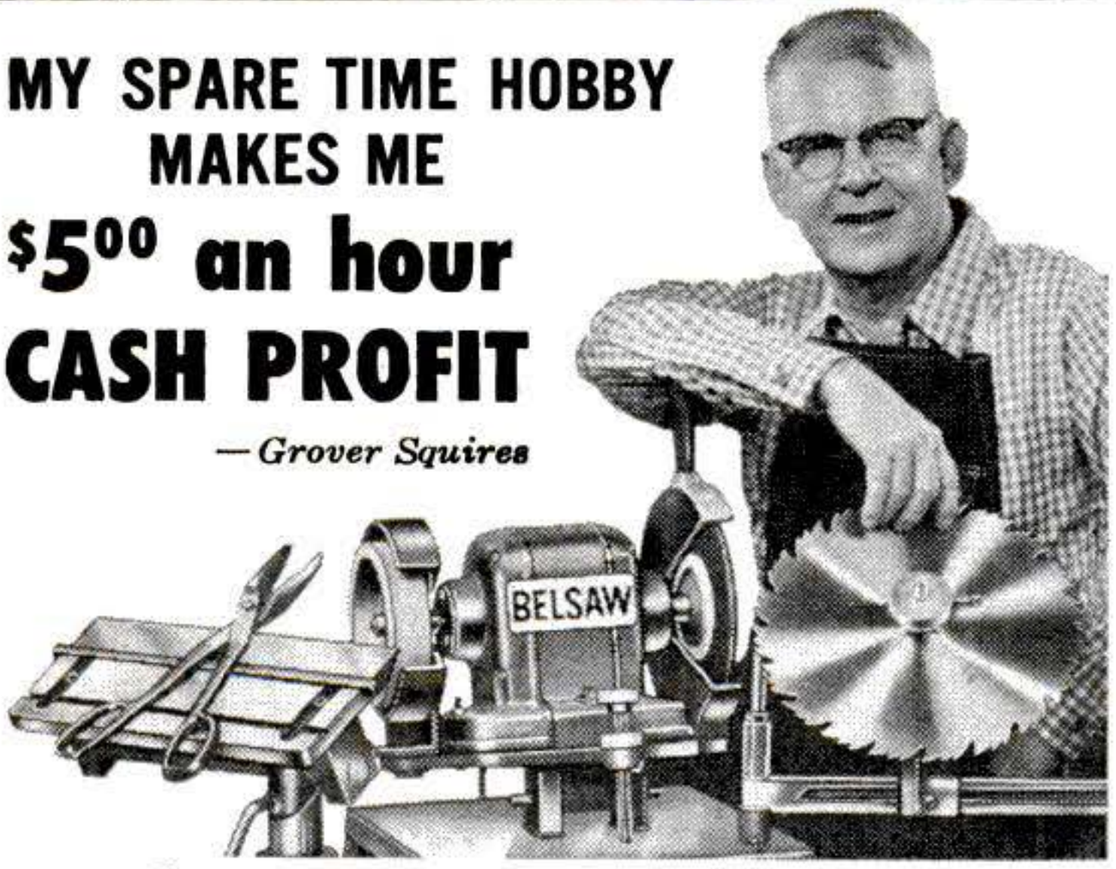

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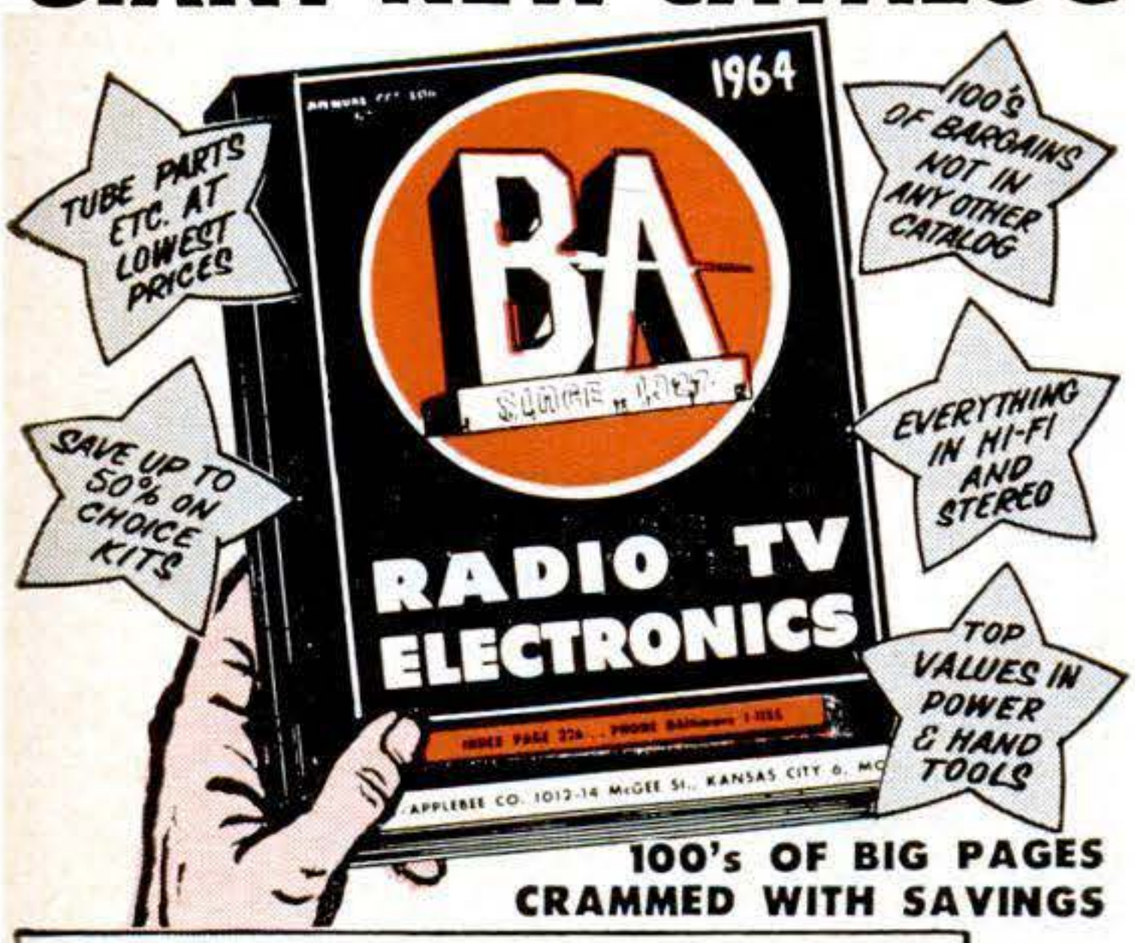

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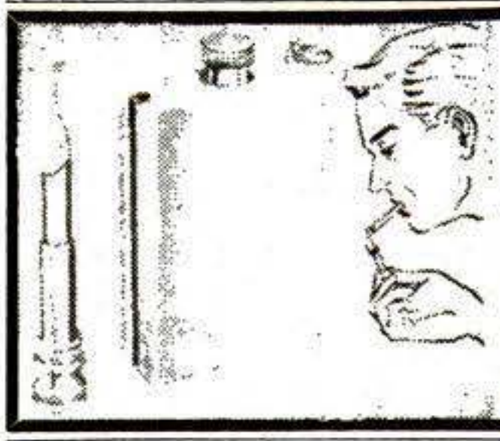

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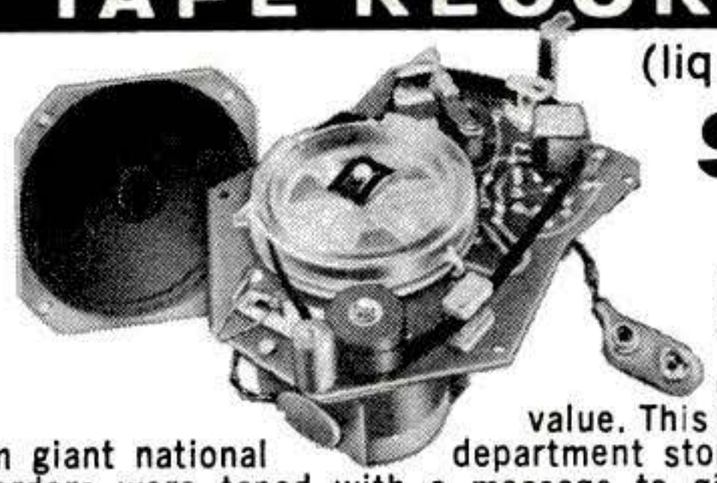

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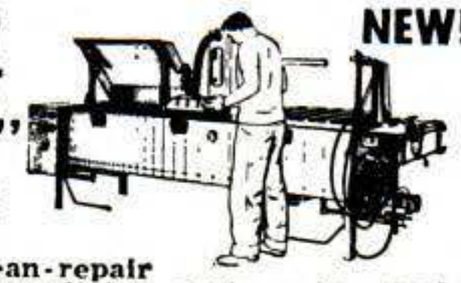

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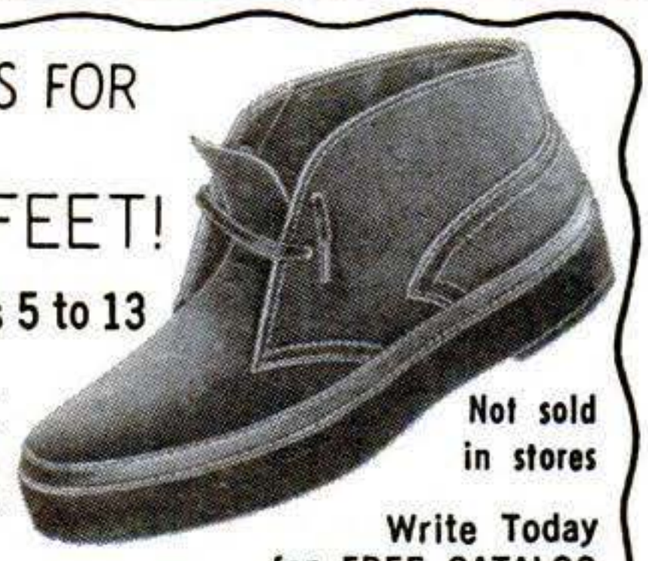

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Detroit report

By Devon Francis

Dark horses

Watch Plymouth and Dodge on the stock-car race tracks. Ford had competition. In recent NASCAR events Plymouth finished first at Nashville, Tenn., Greenville, S. C., and Bridgehampton, N. Y., and second at Bristol, Tenn., and Asheville, N. C. Dodge finished second at Nashville and at Savannah.

Significantly, Nichels Engineering of Highland, Ind., a long-time major builder of Pontiac stock racers, has switched to Plymouth and Dodge. The two cars are being readied for the races remaining on the 1963 NASCAR calendar.

Here come more car clinics

With the first Mobil Repair Center, in Cherry Hill, N. J., a roaring success (see the exclusive POPULAR SCIENCE story on it in last March issue), the Mobil Oil Co. now plans to open four more centers. To be completed by next spring, they probably will be located in California, Texas, New York, and Maryland.

Cars may be left for repair and/or diagnosis at any nearby Mobil gas station.

Double vision

The visitor to the Ford Museum in Dearborn presently will see two 1896 Ford Quadricycles (which we reported on last June in another exclusive story). One is the original, the second a replica. The builder of the second one, George De Angelis, sold it to the museum, now has a contract to build one for the 1964 New York World's Fair.

Compulsory seat belts

Twenty states and the District of Columbia now require seat belts in new cars. Six states are considering similar laws.

The history of seat-belt laws has been stormy. Some opponents argue that the laws have no teeth because they make no provision to enforce the use of belts.

Another objection was voiced by the Governor of South Dakota: proposed legislation in his state would force motorists to buy belts from one source—the dealer who sells the car.

By end of the year, the issue may be moot. Auto makers will probably start putting them in all new cars.

Red: go. Green: whoa.

If the car ahead of you is red, chances are you'll be more tempted to step on the gas and pass than if it were black, gray, blue, or green. This is the finding of the British Motor Corp. of Canada.

Some drivers, reports BMC, may even be urged subconsciously to go through red lights. Certain bright shades of yellow have a similar exhilarating effect on drivers. Green, though, is a soothing, tranquilizing color.

Juice rationing

To prevent excessive discharge of batteries, Daimler-Benz of Germany has brought out a device that divides radio, heater, starter, and other electrical accessories into two groups: essential and nonessential. When the electrolyte level falls below a safe level, the battery-mounted device cuts out all nonessential circuits. A warning light mounted on the essential circuit, tells the driver he's on thin rations.

Villainy at the stern

With closed crankcase ventilation standard on all new U. S. cars, the CMVAPCB (California Motor Vehicle Air Pollution Control Board), is busily training its sights on another villain—the exhaust pipe. Several gadgets that claim to cut down hydrocarbon emissions from exhausts have been tested, and flopped miserably. But California officials now privately claim they expect to have at least two workable devices by next July.

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OUR MAN IN DAYTONA

It was hot at Daytona. You could fry an egg on the track. And when you feel real proud about what you've built, you send it here to find out if it's as good as you think it is. To Daytona. Or Darlington. Or to Pike's Peak. Or to Indy with its proud heritage running two bricks wide across the finish line.

If you really want to know about things like strength, durability, you lay your product on the line before 300,000 customers. Let it stand on its own.

Fireball Roberts tamed the heat and humidity in a '63 Ford at Daytona. On old Pike's Peak, Parnelli Jones took a new Merc up in less time than any stocker in history—or sports car either, for that matter. At Darlington it was Fred Lorenzen in a Ford. And at Indianapolis, Jimmy Clark toured the brickyard in a tradition-smashing, gasoline-burning Lotus-Ford leaving behind all but one of the alcohol-fired Offies.

You could go to the track and probably never notice our crew. They're the guys in the pits with the red-and-white caps on. We make spark plugs. Autolite. We take them to the tracks to see how tough they are.

Fireball used them at Daytona. So did Parnelli at Pike's Peak. Lorenzen at Darlington. Jimmy Clark at Indy. In fact, drivers using our plugs won 8 out of 10 major stock car races (those over 250 miles long) as of July 4 this year. That's tough to beat.

So's the plug we make for the tracks. They're heat sealed to prevent compression leakage. And we build them with special electrodes, special ceramic insulators.

One more thing you should know. We build the spark plugs for your car in exactly the same way.

SPARK PLUGS • BATTERIES • SERVICE PARTS

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THE NAME TO REMEMBER WHEN YOU CARE FOR YOUR CAR

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The toughest little kid on the dock: the 1964 Merc 39

This little fellow is the newest arrival in the Mercury family. It's a chip off the old block and the resemblance is obvious. It's pint-sized, but a real roughneck . . . and you won't find a better fisherman anywhere. Merc 39 packs 3.9 horsepower . . . performs like a five hp . . . and it's a miser on fuel. Merc 39 is a single-cylinder water-cooled outboard and has all the quality features of Merc's more powerful twins . . . things like Glide-Angle styling and Jet-Prop exhaust.

AND THAT'S THE SMALLEST NEWS FOR 1964. Here's Mercury's Silver Anniversary Fleet . . . the result of 25 years of engineering leadership in outboards. It's the most complete selection of outboard power ever offered.

SEE YOUR MERCURY DEALER SOON! HE'S LISTED IN THE YELLOW PAGES.

MERCURY

KIEKHAEFER MERCURY

SILVER ANNIVERSARY FLEET

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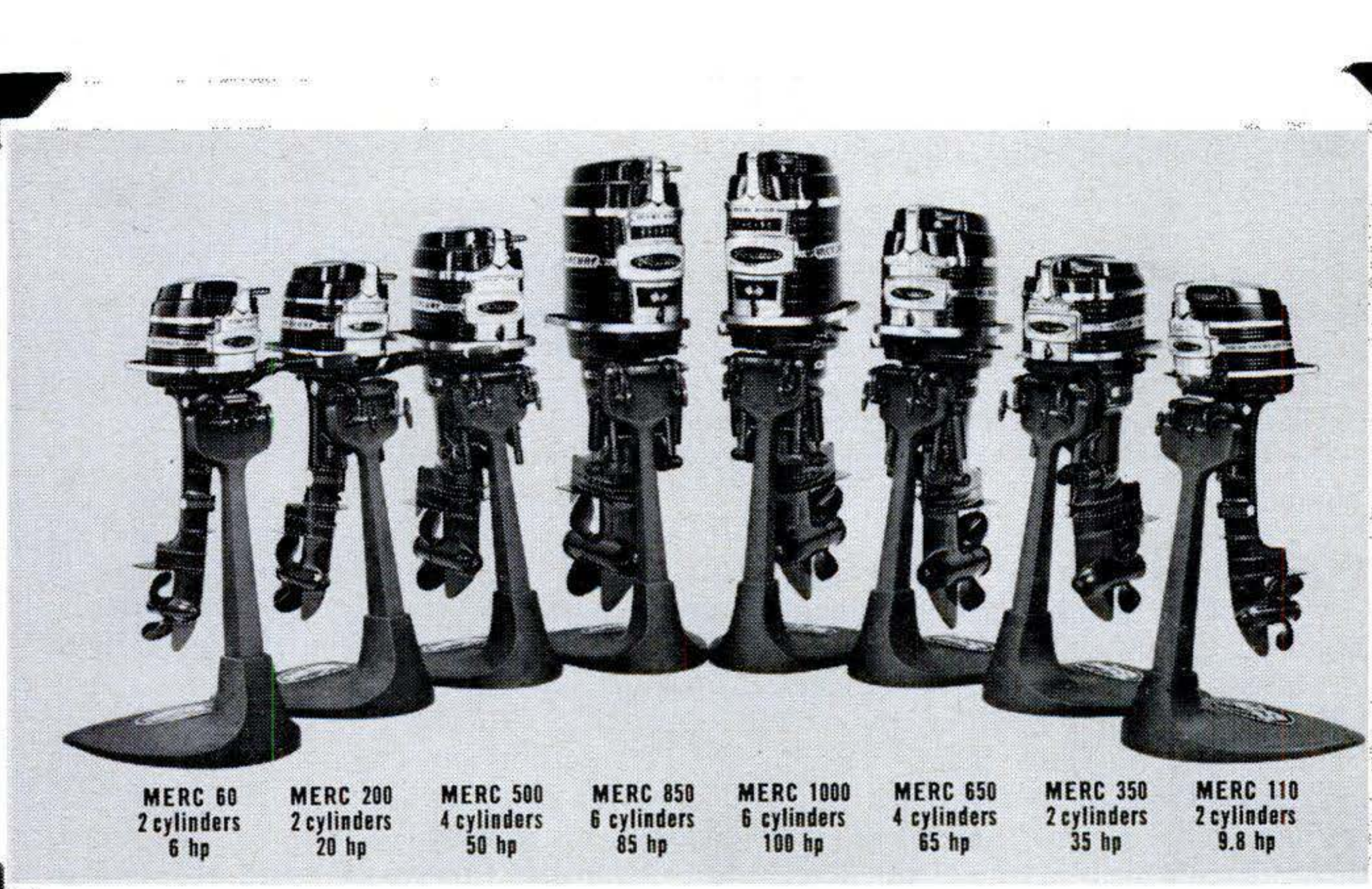

The 3.9 hp Merc 39 is not in this picture. It couldn't wait to go fishing.

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Popular Science *100 and 30 years ago...*

1873 "**All structures,** large or small, have a definite rate of vibration, depending on their material, size, and shape. If one body vibrates, others near it will respond, if their rates of vibration agree.

"We have here the reason for the rule observed in armies when they cross a bridge—to stop the music, break step and open columns lest the measured cadence of a mass of men should urge the bridge to vibrate beyond its sphere of cohesion. A neglect of this rule has led to serious accidents. The Broughton Bridge near Manchester, gave way beneath the measured tread of only 60 men. A battalion of French infantry crossing a bridge at Angers ignored the order to break ranks and the bridge collapsed killing 280 men."

"**M. Paul Bert** has noted the effects of high atmospheric pressure on 'animals. Placing sparrows in oxygen under a pressure 3½ times the sea-level norm, he found the birds seized with violent convulsions. The same result followed when sparrows were placed in common air under a pressure of 17 atmospheres. At 22 atmospheres the spasms were fatal.

"With dogs an oxygen pressure of 3½ atmospheres produced convulsions, while five atmospheres were fatal. The amount of oxygen in the arteries was found to be considerably less than twice the normal quantity. Hence the author's startling conclusion that oxygen is the most fearful poison known."

1903 "**Not long ago** Mr. Marconi invented a telegraphic instrument based upon his discovery that the magnetic hysteresis of iron can be annulled by electric oscillations. A single wave or train of waves received by the instrument's aerial, will express itself as an audible tick in a telephone connected to it. If several groups of closely adjacent wave trains are sent, they will be heard as a short continuous noise equivalent to the Morse *dash.*

"It was by means of this remarkably ingenious instrument that Mr. Marconi was able to detect the waves sent across the Atlantic from power stations in Nova Scotia, Canada, and from Cape Cod, Mass.

"There can be no question that Mr. Marconi's magnetic detector is the most sensitive device yet invented for the detection of Hertzian waves."

"**The Spanish-American War** revealed the South to itself. It is not fanciful to attribute the new educational awakening there in part to that outside contact. But whatever the cause, the fact is here to reckon with—a desire for education. Education throughout the South is being sought today in the face of great difficulties. Many a southern man and woman, today buried in obscure villages, has fairly earned a brevet for gallantry in action in the struggle with stifling social conditions."

1933 "**How the speed of motorboats** may be doubled without increasing their power was demonstrated in spectacular fashion at Philadelphia, Pa., the other day, when Dr. Oskar G. Tietjens,

Westinghouse research engineer, demonstrated the first full-sized model of his 'hydrofoil' speedboat. Thin steel vanes, or hydrofoils, set beneath the craft, lifted its hull entirely clear of the water at full speed, and the absence of fluid friction permitted the boat to skim the water with amazing velocity."

"**To transport passengers swiftly** between Paris and its outlying airports, France is experimenting with a helicopter taxi. Capable of hovering motionless and of rising or descending vertically, such a craft could land on a city rooftop. Officials have high hopes for a craft just completed by an engineer named Florinne, and patterned after Raoul Pescara's pioneer models."

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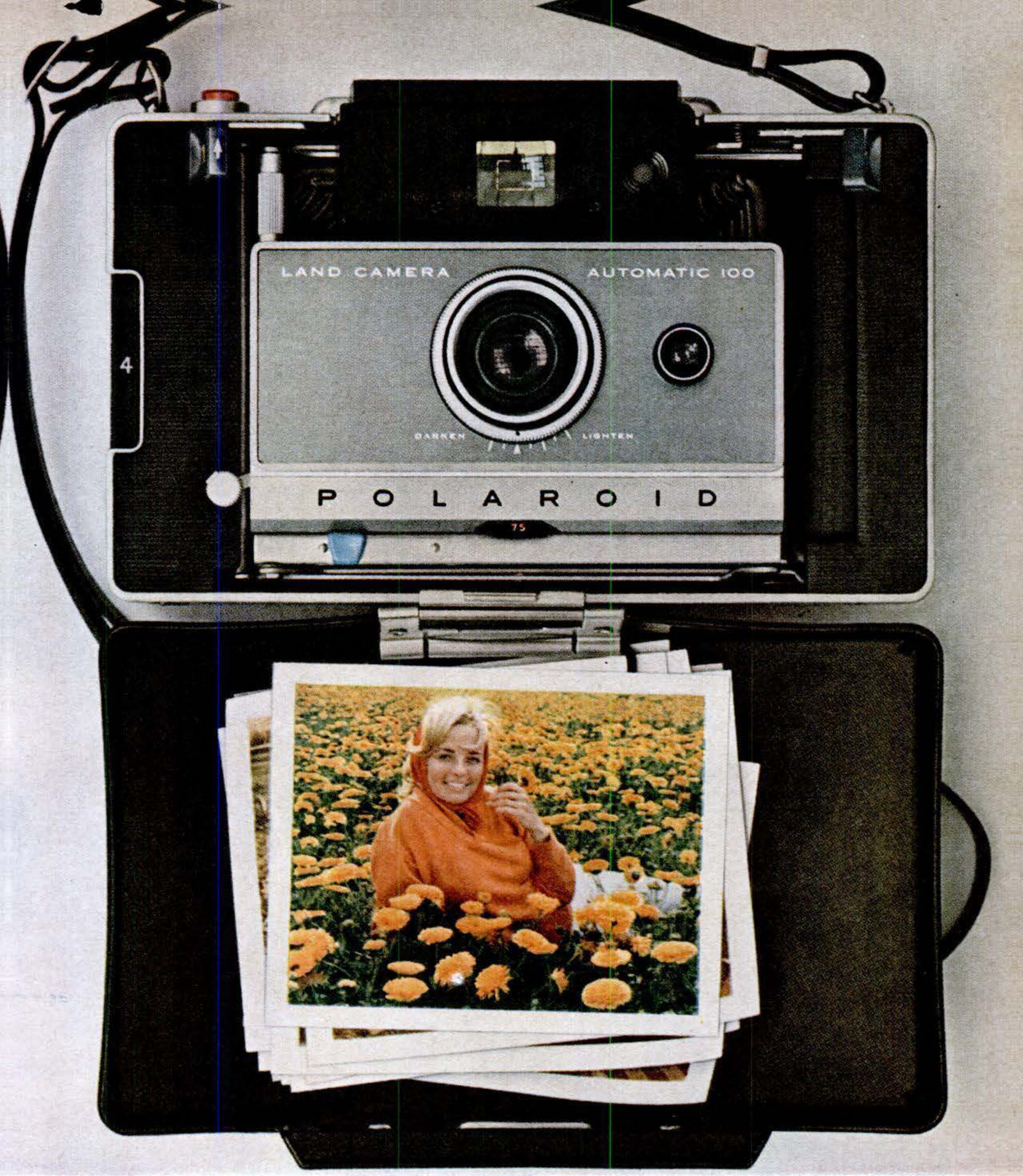

Now—get color pictures in 50 seconds with the world's most advanced camera

Everywhere, reaction to the new Polaroid 50-second color film has been exciting. The colors are rich and clear. Skin tones are remarkably accurate.

Now Polaroid introduces a camera designed to take maximum advantage of this astonishing new film. The Polaroid Color Pack Camera is the most advanced camera in the world. With its transistorized shutter, it can do things no camera could ever do before. You can shoot color flash pictures indoors without flash guides (the electric eye reads the flash and sets the exposure automatically). You can shoot 10-second black and white pictures in low light levels (like a candlelit scene) and the shutter automatically makes the correct setting for a time exposure.

The camera is easy to use. It's also lighter than many 35mm cameras. The film comes in a pack that loads in 7 seconds. See the world's most advanced camera at your dealer's now.

"POLAROID"®

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This is the solid, silent Super Torque Ford for 1964–bred in open competition, built for total performance –hundreds of pounds stronger, smoother and steadier than any other car in its field. Come drive it!

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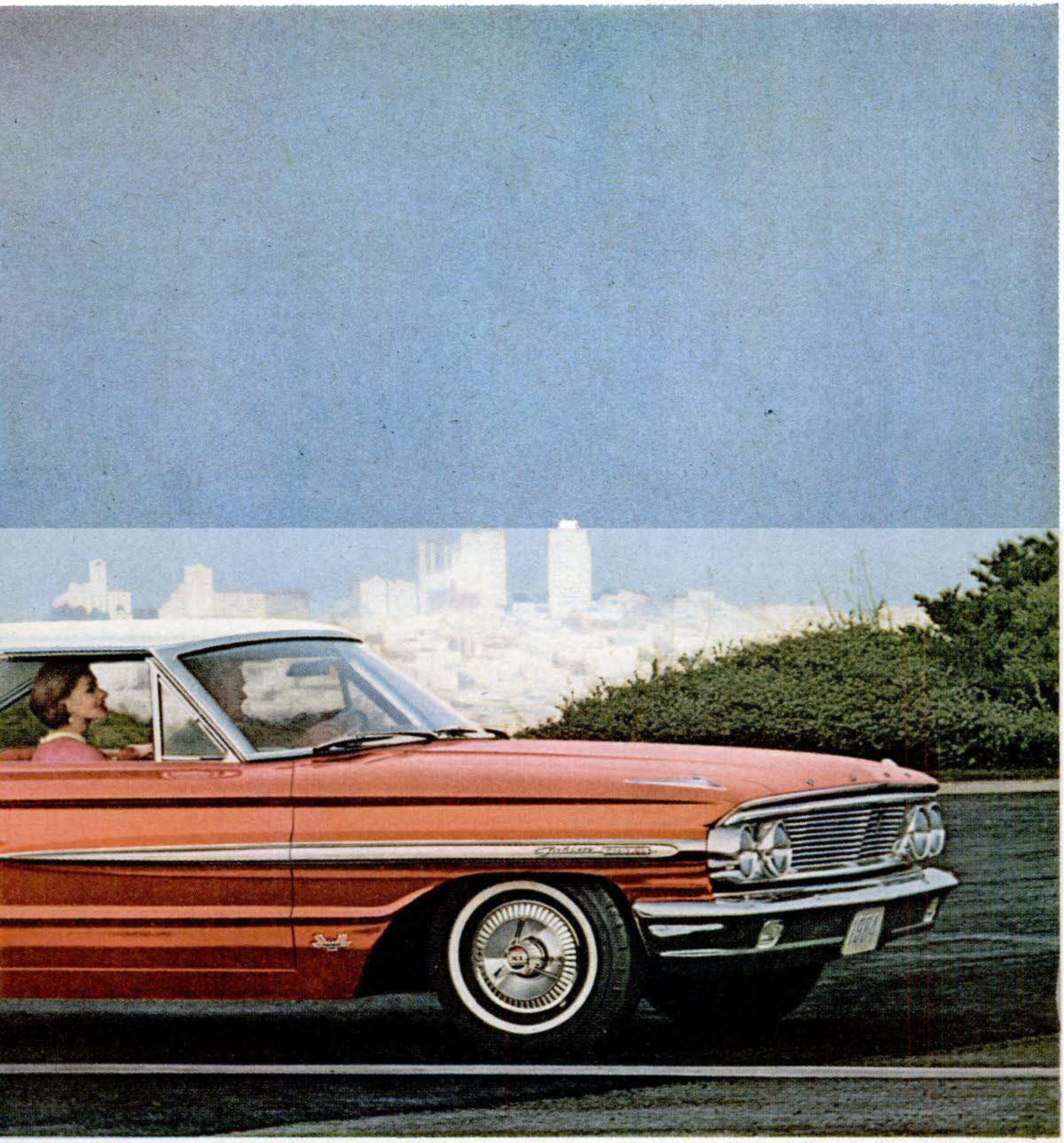

Foreground: Ford Galaxie 500/XL 2-door Hardtop Background: Ford Galaxie 500 4-door Hardtop

THE YEAR of the Test Drive is on! This '64 Super Torque Ford is so dramatically changed, you have to drive it to believe it. That's why we're inviting the whole country to come try *total performance*.

All we learned in a year of successes in races, rallies, economy runs, braking and acceleration trials has bred into the '64 Fords the kind of *total performance* you just can't create on the proving grounds alone. They're hard-muscled, fast-moving, sure-footed. Open competition helped make them that way. They're more substantial than ever, with more steel in their frames, huskier bodies, more solid road-hugging strength than anything in their field A remarkable suspension system gives them a ride as smooth as cars costing thousands more. Did you say, "Show me"? How about this week?

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FOR A CHANGE!

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Falcon • Fairlane • Ford • Thunderbird

All 44 new Falcons, Fairlanes, Fords, and Thunderbirds are at your Ford Dealer's now!

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Popular Science
REG. U. S. PAT. OFF. Monthly

The '64 Look

Chevelle and Unisphere

On the cover of this issue of Popular Science you see two big newsmakers for 1964—a new brand of passenger car, and the theme structure of New York's World's Fair.

The car: Chevrolet's smart Chevelle—bigger than Chevy II, smaller than the Impala. The structure in the background: the Fair's Unisphere.

In the following 12 pages, you will see the other new cars—now

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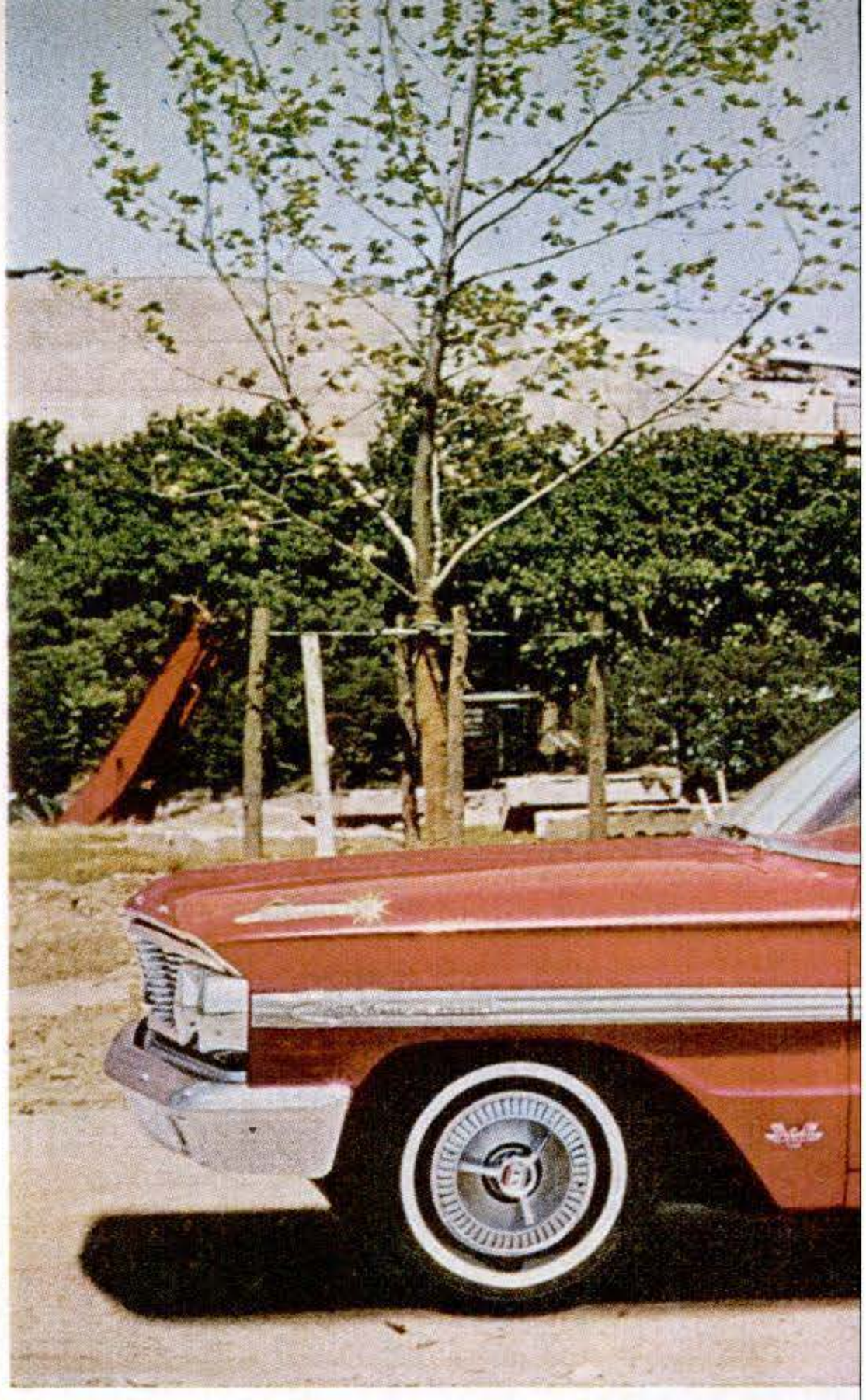
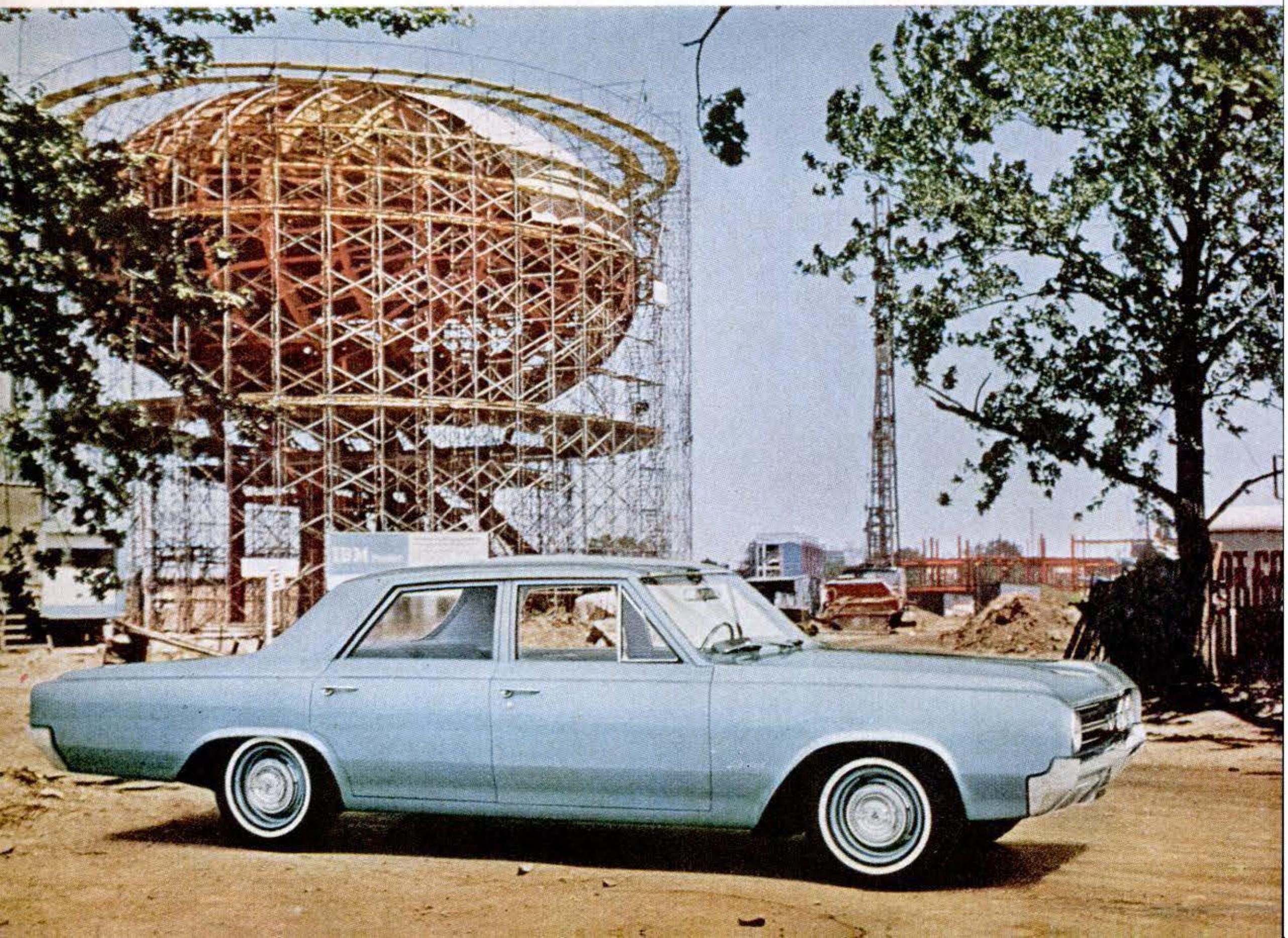
chrysalis-fresh in showrooms from Bangor to Los Angeles, Seattle to Key West—plus a dozen of the Fair's buildings as they appeared last summer, during construction.

Then, in succeeding pages you will find descriptions of the cars by Popular Science auto specialists, the men who drove them for you on test tracks months in advance of their introduction.

PHOTOGRAPHED FOR POPULAR SCIENCE BY BILL MORRIS





Muscular Galaxie struts in new attire

You are looking at an automobile (above) that in the last year has got U.S. motoring all shook up. It's the Galaxie, Ford's top performer, and it has been copping stock-car races from Riverside to Daytona. A 427-inch engine turns out a thundering 425 horsepower in the street version, a lot more on the track. The mint-bright Galaxie has been given a new dress by the stylists. The building pictured in the background is, appropriately, the Ford Motor Co. pavilion at New York's World's Fair. It will feature a glass-enclosed rotunda-like structure 235 feet in diameter and 56 feet high, encased in 65 pylons 100 feet tall.

Olds F-85 grows and grows in size and horsepower

Olds' 1964 "small" car, the F-85, is growing out of its britches. At 203 inches, its overall length is almost 11 inches greater than a year ago, 15 greater than in the 1962 model year. And up goes the horsepower!—from a bustling 215 to a roistering 260 in the Cutlass version. The torque-converter transmission, replacing its Hydra-Matic, is brand-new. So is its outside sheet metal. A shrewd eye will detect similarities between the F-85 and some other General Motors cars in the new crop. Shown in the background is the almost-completed International Business Machines building at the Fair.

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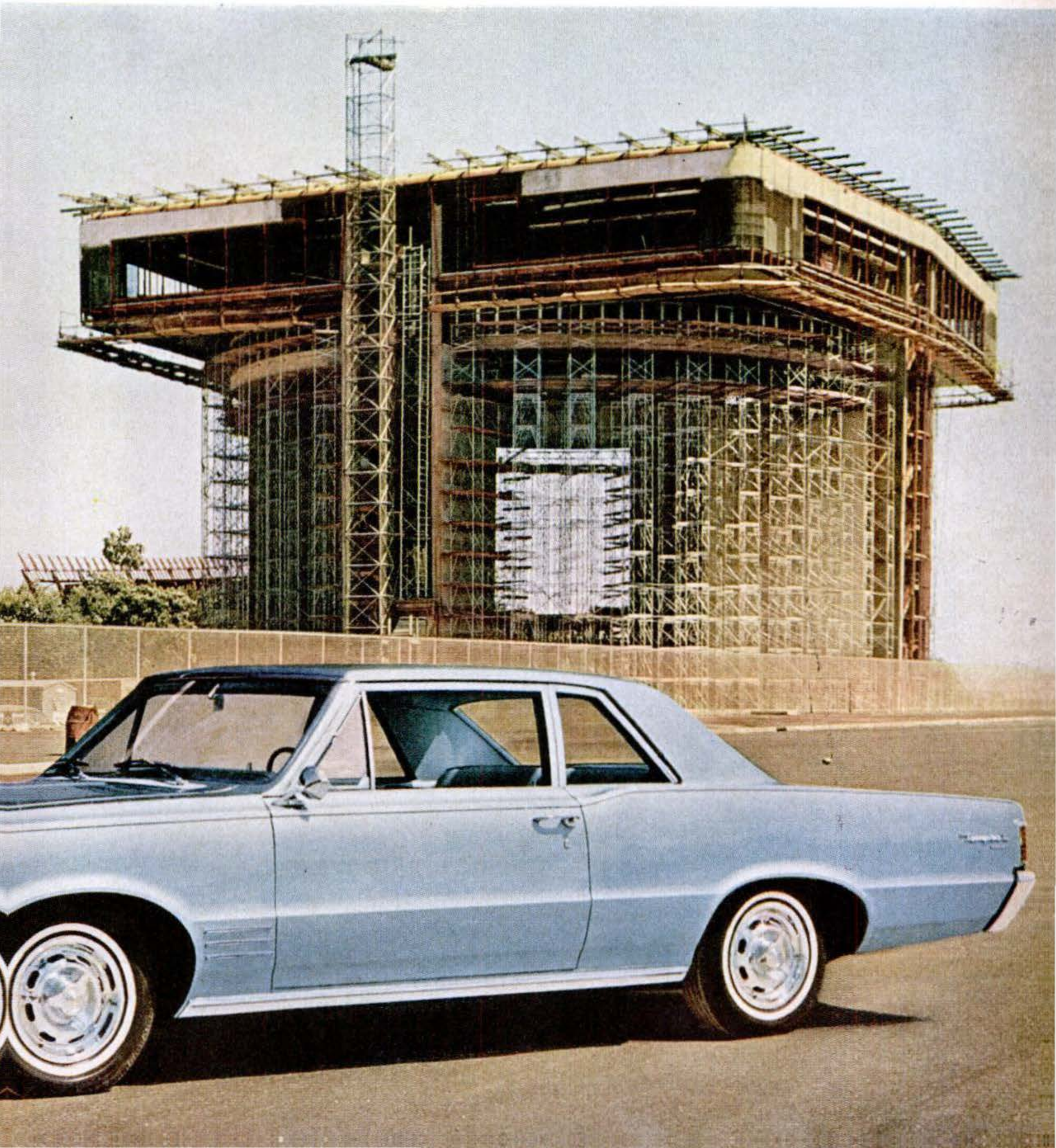
The word for the first new Comet in three years: pulchritudinous

You won't recognize the Comet, Mercury's "compact" (above), shown here in its Caliente model. In completely new attire for the first time since its coming-out party three years ago, the Comet wears spangles. That isn't all. The top horsepower has gone whoosh!—from 164 acquired with a V-8 engine in the middle of the 1963 model year to a whopping 210. There's a new three-speed automatic transmission, an instrument panel with a simulated wood grain on its lower edge, and no less than three dozen different accessories. Ford Motor hasn't yielded to the temptation to stretch the car's length, though. It's about the same size. The backdrop for this portrait is GE's Progressland pavilion. That dome, 200 feet in diameter, will be crowned with 1,000 lights, burning enough juice each night to supply an average household for months.

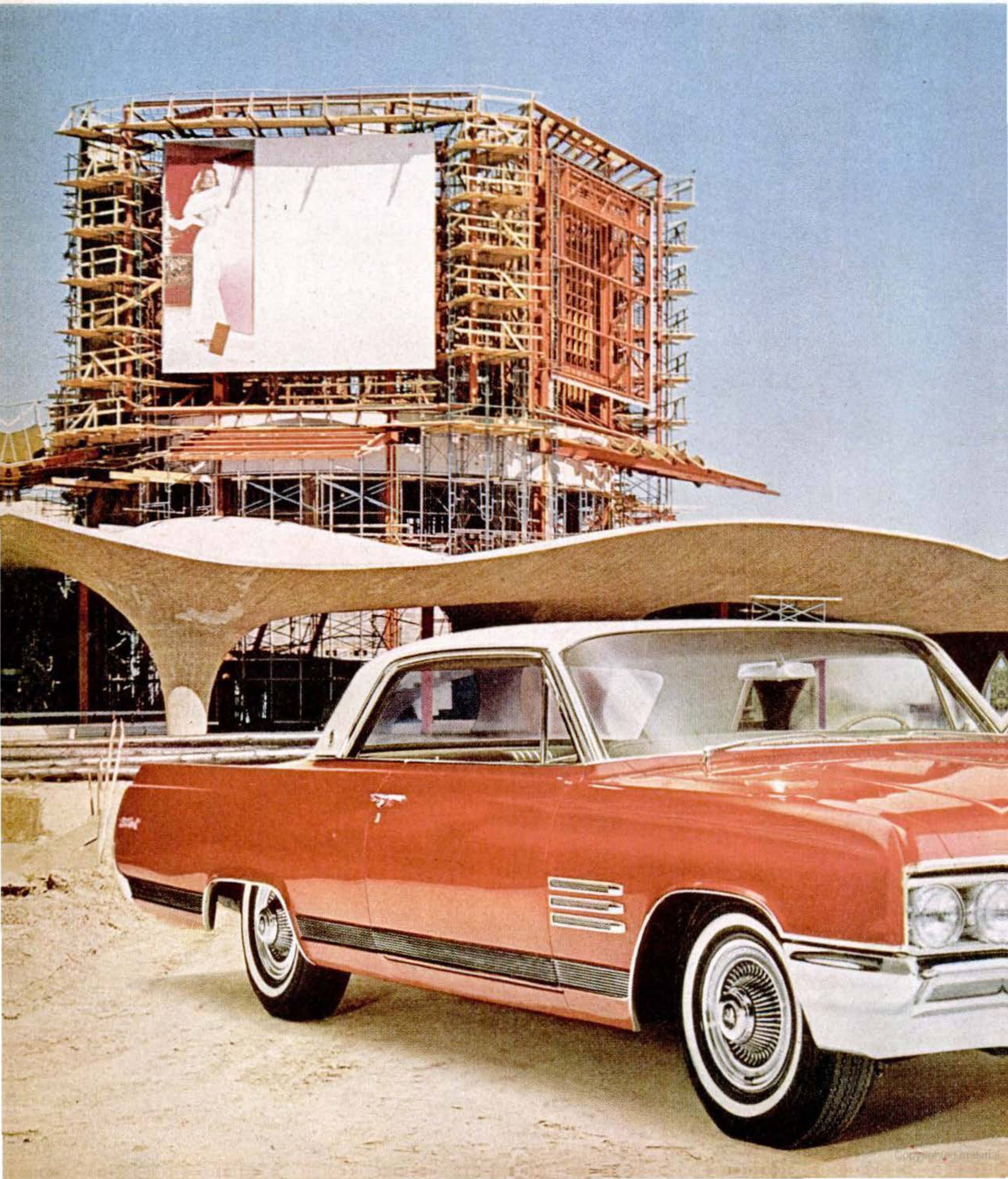
Little Tempest begins to resemble its big brothers

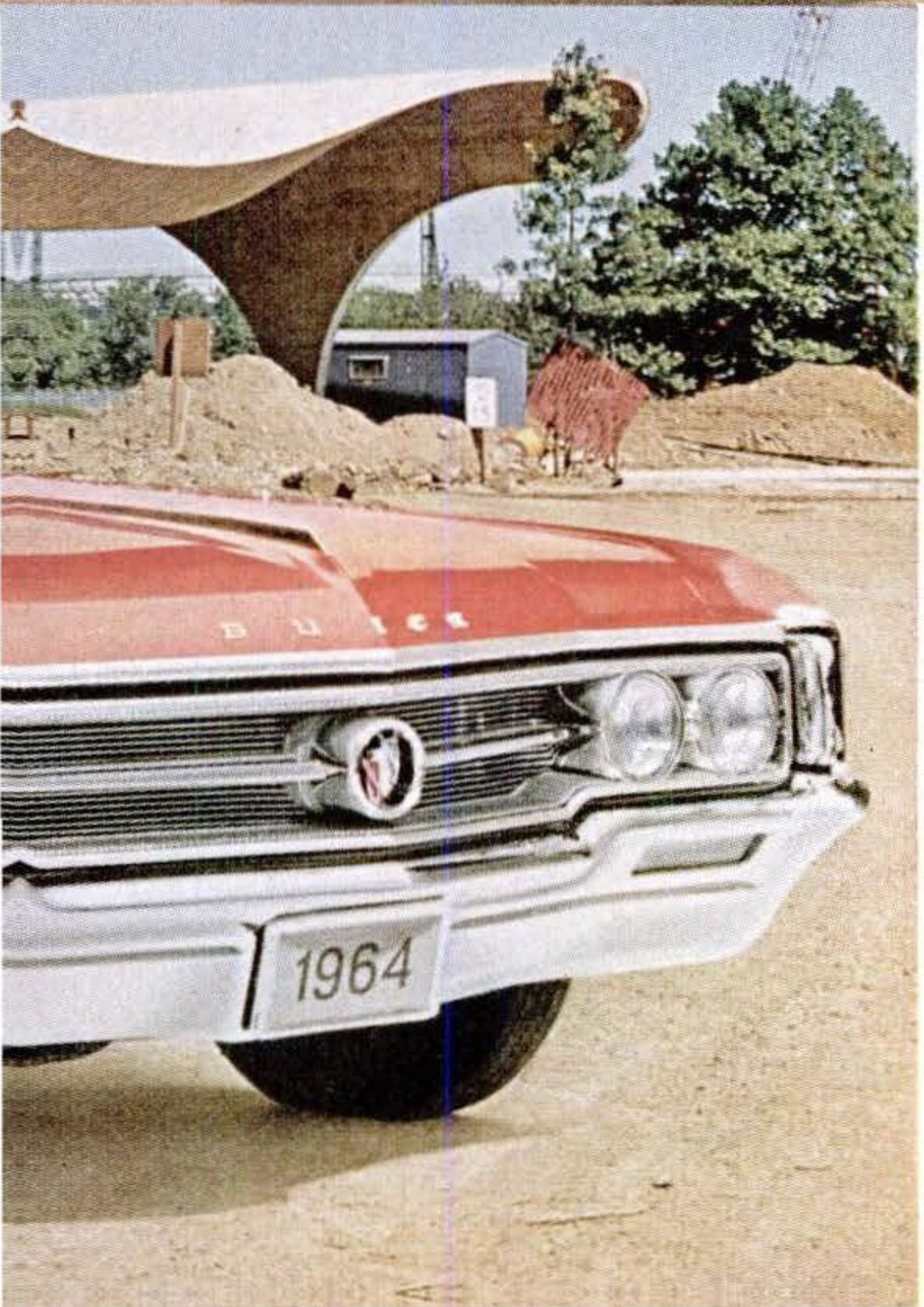
If the Olds F-85 is bigger, so is Pontiac's little Tempest. In fact, they're exactly the same length—203 inches. That means the Tempest has grown almost 14 inches since its unveiling in 1960. (The F-85, Tempest, Chevelle, and Buick Special have a lot in common for '64.) Gone is the Tempest's rear-mounted transmission, its 4-cylinder engine. Horsepowers blast up to 280. In new sheet metal, the car has begun to resemble its big brothers in the Pontiac stable. Background: the Fair's Port of New York Authority building, topped by a heliport to provide shuttle service to Manhattan.



Buick's Wildcat boasts new gas economy

Buick's sporty Wildcat (below), a LeSabre model sort of togged out for the country-club set, has a new asset in its milder horsepower versions—of all things, a rather spectacular gas economy. But its optional horsepowers race clear up to 360. There's a new transm'ssion. The "portholes" are stacked for '64. The car is pictured in front of Kodak's Tower of Photography exhibit.





Even the Rambler American is longer and splashier

Rambler American, the smallest car made in this country, has caught the expansion fever, too. For 1964 it's four inches longer. And splashier! Geegaws abound. There's an electric tailgate, for example, in the station-wagon version that has quite a bit more cargo room. Both the front and rear suspensions are new for easier riding and cornering. Behind the car, abuilding, is a monument to the fact that human beings spend a third of their lives in bed. It's the Simmons Mattress Co. exhibit at the Fair.

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The Plymouth: a bit bigger, a bit roomier

A smidgen longer, with a mite more headroom, Plymouth's Fury appears before the Travelers Insurance exhibit.

Chevy gets some restyling touches

The standard Chevrolet (left) is lightly restyled for '64. In the background: the General Motors building.

Lark incorporates some fresh machinery

Studebaker's Lark, lower and longer, also has come up with mechanical improvements. Background: Bell System exhibit.

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Dapper new Dodge rides popularity wave

Better loved in '63 by U. S. motorists than for several years, the '64 Dodge, shown here in its elegant Polara version, abounds in jaunty touches. One of them: an optional between-seats console with a lever—not pushbuttons—for the automatic transmission. The backdrop you see is the New York State building which will have, when complete, three observation towers, the highest rising 200 feet.

The Thunderbird: new styling and gadgetry

Ford's Thunderbird, at long last, is rid of that front end—which from the side looked like a petulant sea bass. The styling, all new, is nothing short of exquisite. Wheels are an inch bigger, the tires fatter. A flip of a switch opens a rear vent on the package shelf. That structure in the rear is Shea Stadium, the New York Mets' ball park which, when finished, will seat 55,000 fans.

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Mercury puts on Sunday best for 25th birthday

The Mercury is celebrating its silver anniversary. So, for '64, it's all dressed up in new duds. Bursting with horsepower in its high-performance models, the car has bigger—and, naturally, more ornate—interiors. Revived: Merc's Montclair line, between the Monterey and the luxury Park Lane. Fair's Gas Industries building, in background of picture, will house, among other things, a carousel.

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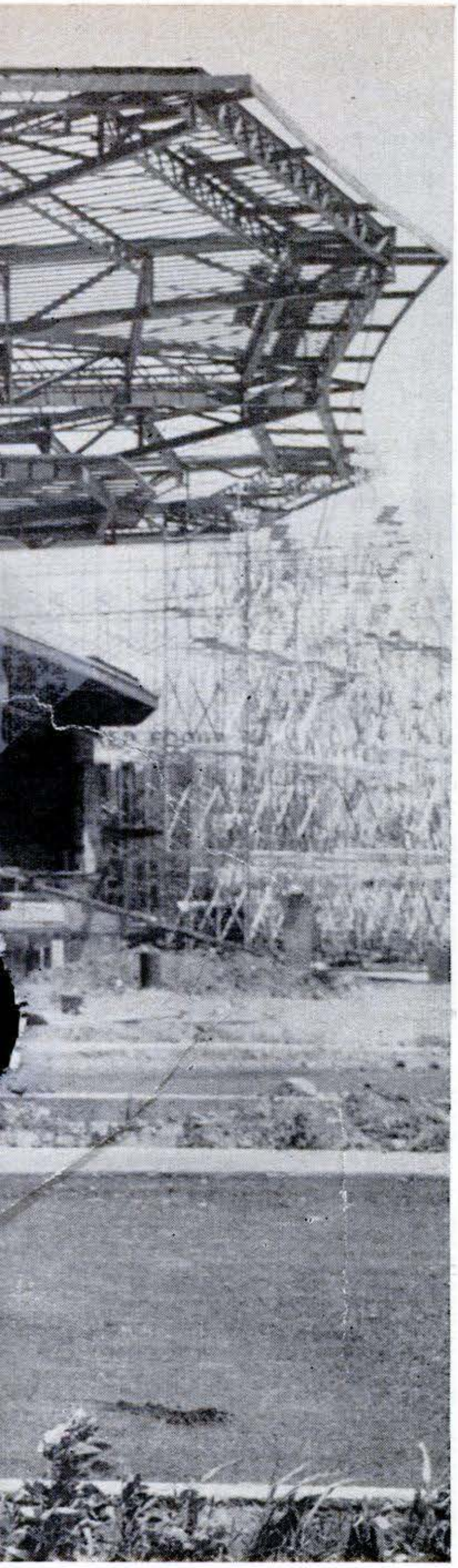

To see how the Fair buildings will look when they open, turn to page 90.

So much for style ...now for a more critical look

By Devon Francis and Alex Markovich

TRENDS in auto making are like the tides—ponderous, powerful, and predictable. Here are highlights of the trends in this model year:

New car, new looks Chevy's Chevelle is not only a new brand name, it's a new car. In addition, there's a new sporty vehicle by Oldsmobile. Eleven other cars with familiar names are in wholly new attire. The '64 cars are in good taste and handsome, but individually they are without distinction—partly a result of standardization for manufacturing economy. Four of the "compact" cars are compact no more.

The racing image Many horsepowers are up. In a boom year, this was inevitable. Stock-car race results have contributed. Some new engines are appearing.

New transmissions Equally important, the new cars are fitted with transmissions designed for performance. A significant move: For economy, General Motors is beginning to standardize on its automatic drives—which means the end of Hydra-Matic by 1965.

The end of idiocy Despite a proliferation in accessories, the new cars are practical, sturdy, easily maintained. They embody no knee-knocking windshield pillars, tail fins.

Tremendous trifles The bulk of the news for '64 lies in the subtleties of engineering research. Scores of little things improve the ride and handling. Ford finally has moved its starter-ignition key to the right side of the steering column. GM finally has adopted a sensible P-R-N-D-L automatic drive quadrant. And, finally, there's a retractable seat belt.

FOR DETAILS, TURN THE PAGE 77

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What's new at Chevrolet

- an in-between car
- fresh Corvair suspension
- styling refinements
- a V-8 for the Chevy II
- more power for the Corvette

Chevelle: a new-size car

World's biggest auto maker leagues with other General Motors divisions to produce some common-design vehicles

Chevelle takes hard turns with aplomb. In closed models, curved windows make most of car's interior dimensions almost equal to regular Chevrolet's. Super Sport's console-mounted automatic drive selector (right picture) has lockouts for reverse and low gear.

FOR the last two years the Chevrolet people—the world's biggest auto makers—have been thoughtfully biting their lower lips over a problem.

Their standard passenger car was so bloated that it was pushing 17½ feet in length (as indeed was its chief competitor, the Ford).

But Ford had a car, the Fairlane, that was about what Chevies and Fords were clear back in 1955. Chevy didn't. This was a serious omission. A lot of motorists liked a car that didn't display gnawing ambitions to be a Cadillac.

Last month the Chevrolet management did something about it. They brought out a vehicle that just about matches their 1955 car. In its sassier versions, in fact, it is propelled by essentially the same V-8 engine—grown, however, somewhat more muscular.

The new car is smart. It's sleek. It's downright pretty. They have named it the Chevelle.

The Chevelle is no indifferent performer. With a four-barrel carburetor turning out peak horsepower, the manual four-speed and automatic-transmission versions, both with a 3.08:1 rear axle, accelerate (in seconds) like this:

	4-speed	*Autom.*
0-40 m.p.h.	5.3	5.6
0-60 m.p.h.	9.6	9.8
0-100 m.p.h.	29.0	29.9
40-60 m.p.h.	4.3	4.2

GM's new car, with a length of 194 inches, slips in between the Chevy II (introduced two years ago) at 183

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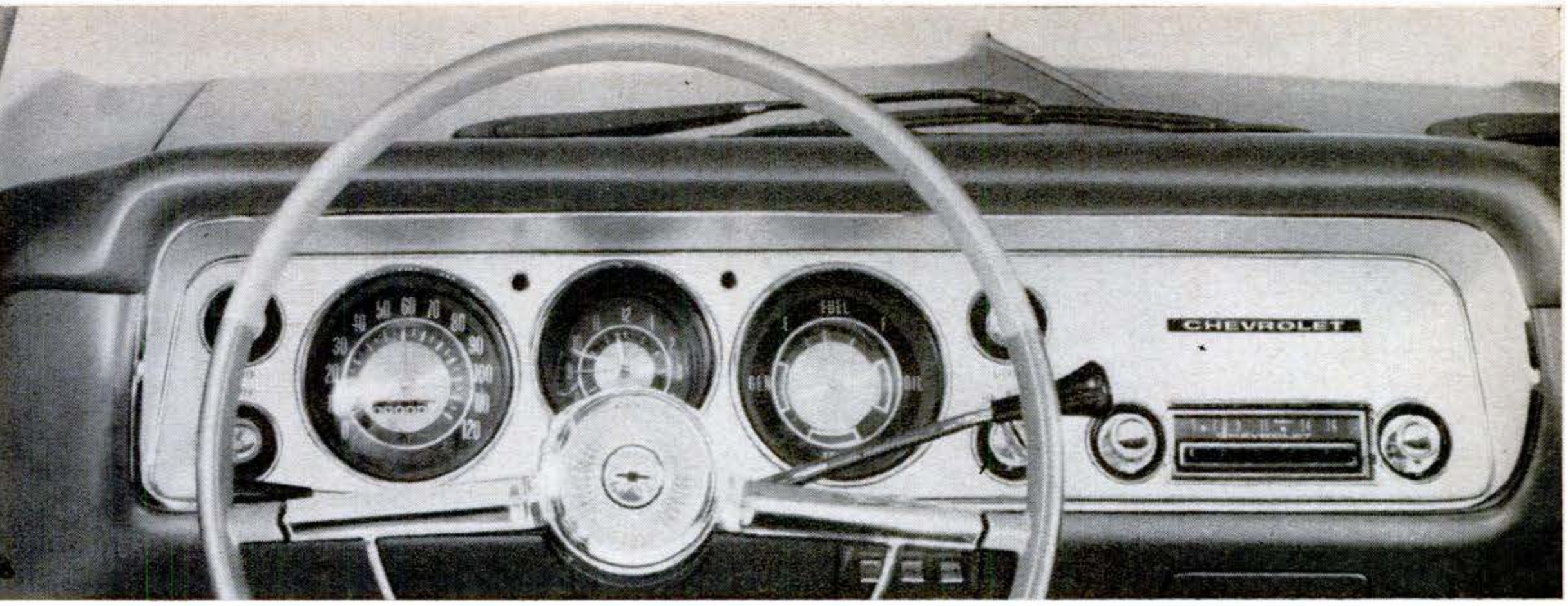

Round, hooded instruments on fancier models have ammeter; gauges for oil pressure, temperature.

inches, and Chevrolet's "big" car, the Impala, at 210 inches. The Chevelle is 14 inches longer than the littlest of Chevrolet's stable of sedans, the Corvair.

More important, it is only 3½ inches shorter than Ford's Fairlane, 6½ longer than American Motors' Rambler Classic. Still more important, the Chevelle has exactly the same wheelbase (115 inches) as the 1964 editions of three other General Motors cars—the Buick Special, Olds F-85, and Pontiac Tempest—and therein lies the real story of this newest member of the Chevrolet line.

To begin with, there is nothing mechanically startling about the Chevelle. It is a conventional automobile. It comes in three series of sedans, sport coupes, convertibles, and station wagons (the Malibu Super Sport, Malibu, and Chevelle 300 in a descending order of ornamentation). It offers the customary, tempting engine options, and the customary, extra-cost accessories, listed like a la carte items on a menu.

What's the Chevelle like when you get it on the road? It rides like a dream, and takes corners with the alacrity of a frightened fawn.

All these characteristics and attributes it shares, however, with those other three GM cars, the Special, F-85, and Tempest, and there is a reason for that. Basically, the three vehicles are much the same. Their frames come from the same factory jigs. Their body structures from their cowls back to their rear windows are identical. In given body styles, so is the sheet metal on the hoods, rear decks, and roofs. So are the suspensions of the four cars. So are the transmissions.

Under the circumstances, differences among these cars are necessarily subtle. The engines do differ here and there, but some similarities exist even in those.

The sameness of the four cars is known as interchangeability among family brands and price classes for manufacturing economy. There is

How the Chevelle got its name

For months prior to its appearance, the new Chevrolet automobile bore all sorts of speculative names. Within the company's inner councils, the working name was "Lovet."

In all, Chevrolet personnel submitted some 3,000 suggestions for a name. Eventually the list was cut to a half-dozen, including Chevalle (which sounded too much like the French for "horse") and Chevair.

Bunky Knudsen, Chevy's general manager, made the final choice. In 1960 he christened the new Pontiac compact the Tempest.

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nothing new about it. GM, Ford, American Motors, and the Chrysler Corp. have practiced it for years, and it has the effect of holding down car prices for the U.S. motorist.

What makes the Chevelle-F-85-Special-Tempest interchangeability for 1964 of particular interest is the complete reversal in design that it involved. To accomplish interchangeability, the GM divisions manufacturing the Special, F-85, and Tempest had to abandon the unitized body—the type of construction wherein the body itself becomes the frame of the car. The Tempest had to dump its flexible drive shaft, rear-mounted transmission, and independent rear-wheel suspension.

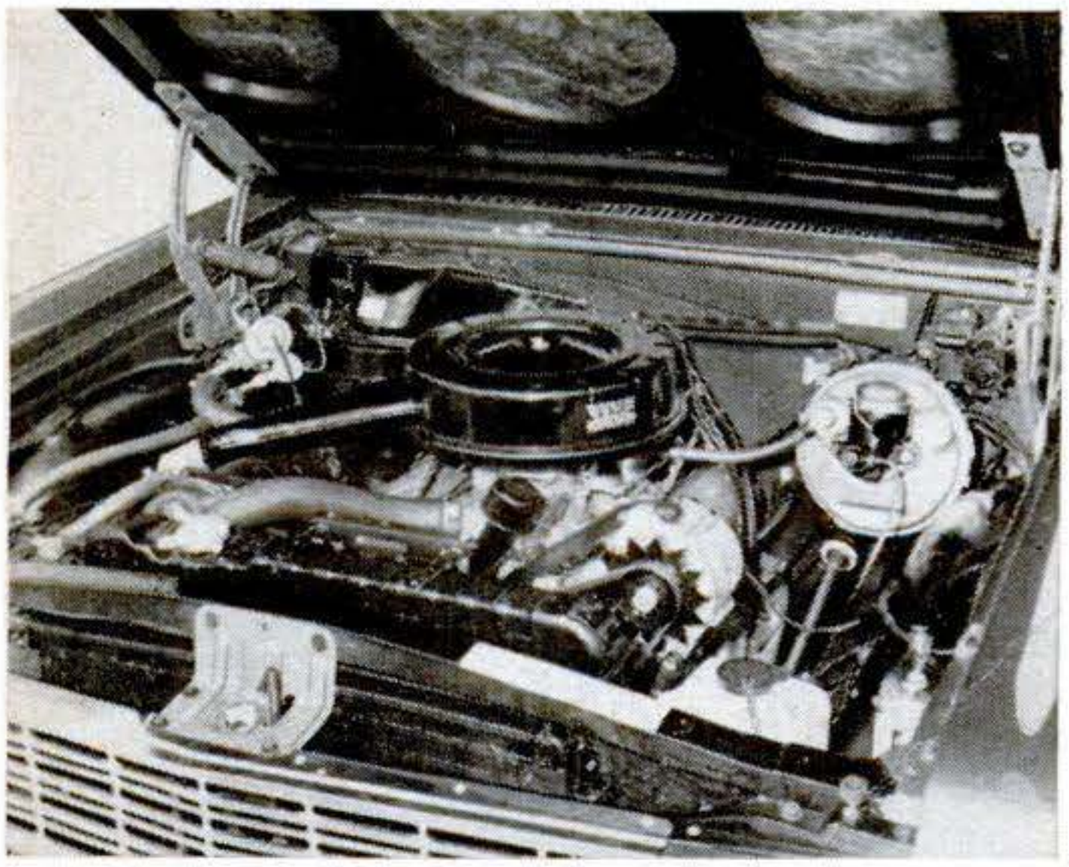
For 1964, all three cars, plus the new Chevelle, incorporate a conventional frame, a conventional body, and conventional suspensions, transmissions, and rear ends.

In power plants, the Tempest has borrowed liberally from Chevrolet for a six-cylinder that replaces its outsize four-in-line, and the F-85 from Buick for a cast-iron V-8 that replaces an aluminum V-8 in both cars.

As this issue of POPULAR SCIENCE went to press, prices had not been announced, but at a customary retail cost of about a dollar per pound of car, the Chevelle will compete for the motorist's money in U.S. showrooms with the F-85, Special, Tempest, Ford Fairlane, and Rambler Classic.

There is other news of Chevrolet for '64 in the four other brands of passenger cars manufactured by this GM division:

Chev's El Camino sedan-like pickup, dropped four years ago, pops up again in Chevelle, but is 6.3 inches lower than the '55 model. Station wagons are 5 inches longer than sedans.



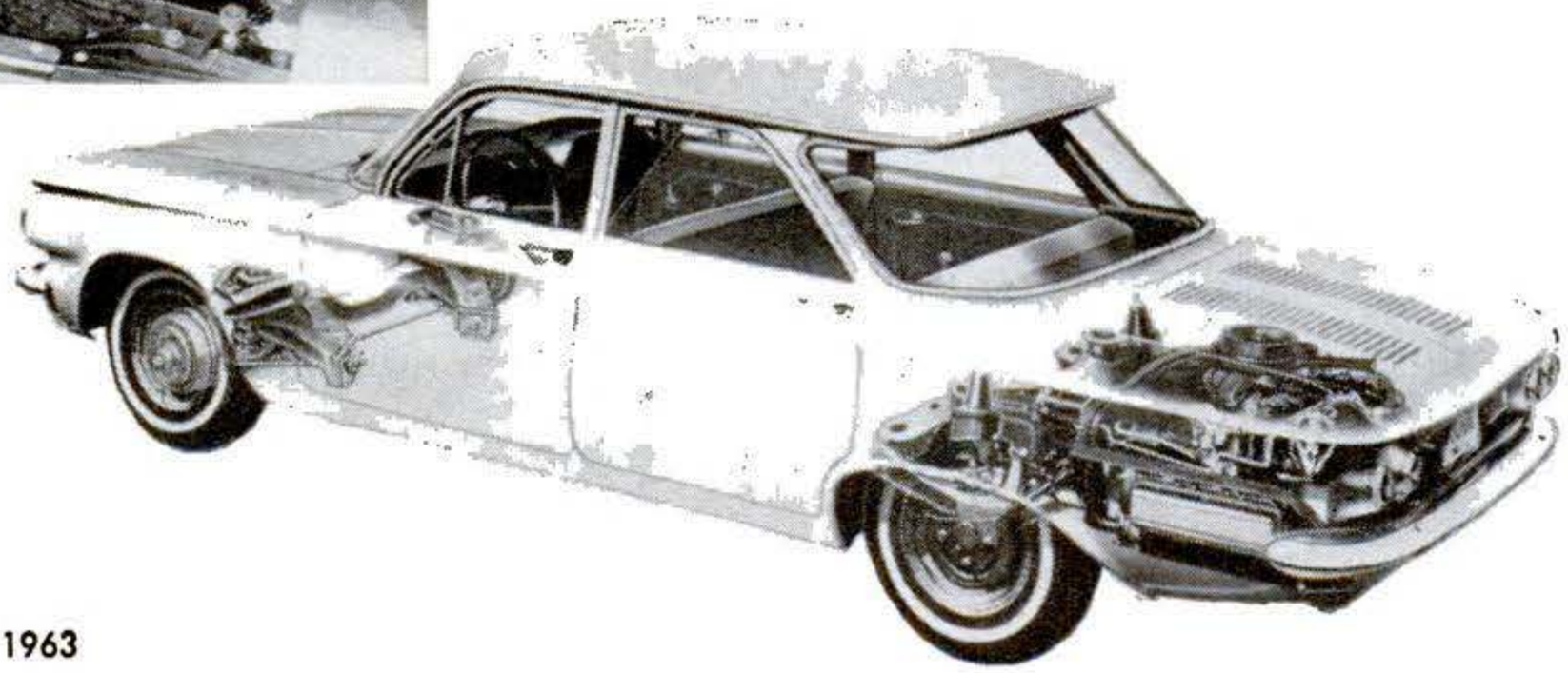
Horsepower of Chevelle's engines range from 220 for an extra-husky V-8 (above) down to 120 for a six. New Corvair suspension (right) incorporates a single-leaf transverse rear spring and heavy front stabilizer bar connecting lower control arms, aiding cornering.

Standard Chevrolet

Restyling includes the front end, hood, rear sheet metal, and deck lid.

Chevrolet has expanded its Super Sport models—those bucket-seat chariots with the chromed console between the seats and script all over the outside to

[Continued on page 206]



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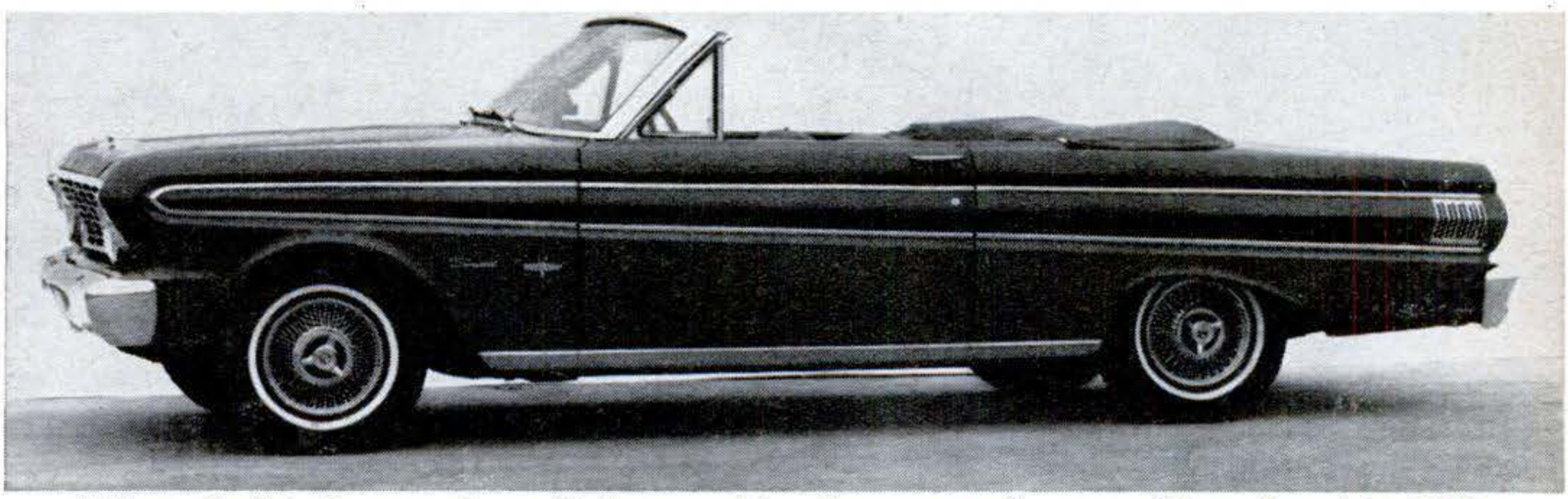
What's new at Ford

- more performance
- new styling
- retractable seat belts
- new transmission
- scratchproof convertible window

Transmissions and power options provide zip

The "performance image" established on racetrack and in rallies paces the auto industry to scorched getaways at the green light



Falcon Sprint, in new dress, little resembles the austere "compact" introduced in 1959.

WHEN Ford cars finished 1-2-3-4-5 in the classic of all U.S. stock-car races—the Daytona 500—last February, it sent a seismic shock through the auto industry.

And when, in May, a Lotus-Ford came close to winning the famous Indianapolis 500, after the same engine placed 1-2 in the Monte Carlo Rally, the message was clear:

For Detroit, 1964 would have to be a performance year.

The new cars announced this fall, including the Fords, were designed for just that. New transmissions boost the performance. With some of them, hard throttle will burn rubber on takeoff. Here and there engine powers are up.

The cars that started all this—the Fords—naturally sizzle. Their power options

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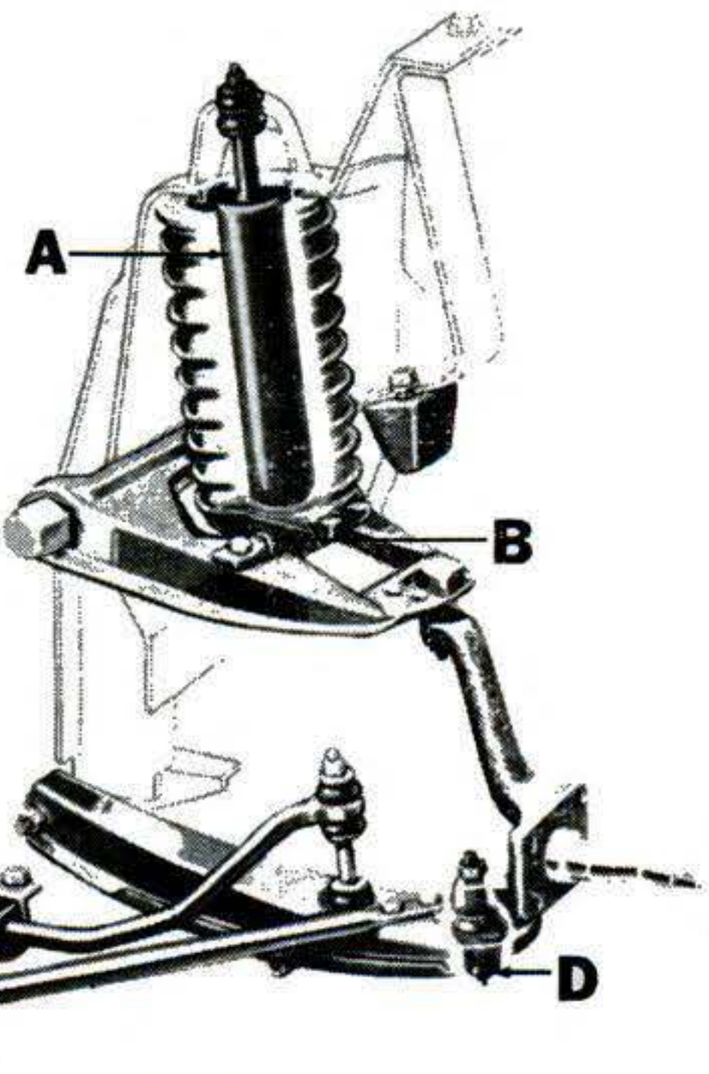

Falcon's front end includes (A) new shock, (B) low-friction pivot arm with rubber spring seat, bigger insulators, (C) revised front strut mounting, (D) improved lower ball joint.

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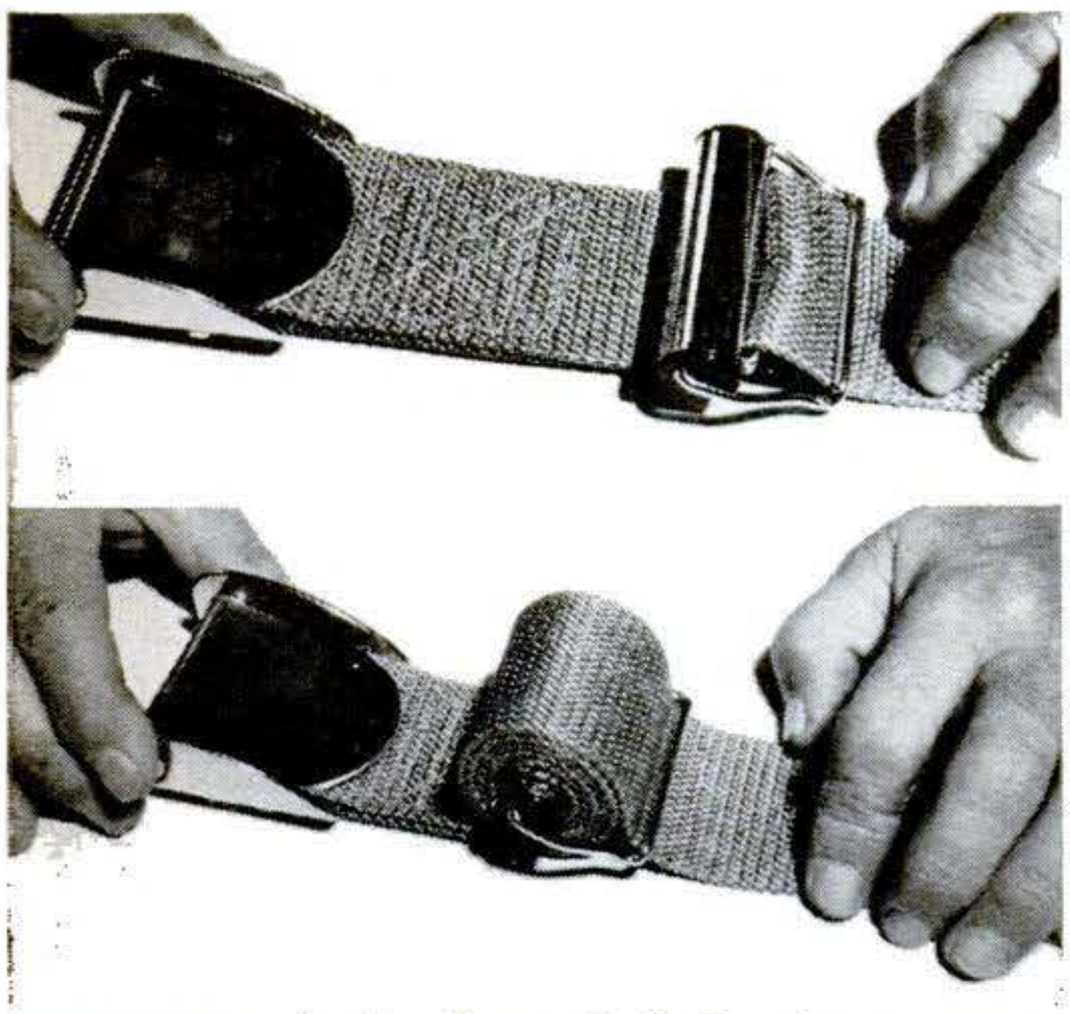
Thunderbird's "cove" rear seat, with passengers' body support at sides as well as back, revives idea of rear-entrance "tonneau" that was high style at turn of century.



Borg-Warner's "Roll-A-Belt," the first retractable seat belt, works on principle of stretching a spring taut. When stretched (top photo), spring is, in effect, "out of the circuit"—belt is snug across driver's and passenger's midriffs. Belt is solid from anchorage to tip—intervening spring enters circuit only through a clasp. When the belt is unbuckled (lower photo), a 60-turn spring, exerting a three-pound pull, retracts it 16 inches. Two springs are used, one for the buckle side, the other for the tongue side of the belt.

abound. A new three-speed transmission has a low gear of 2.46:1 to multiply against a 2.2:1 torque converter.

With an automatic transmission, here are the acceleration figures for the Galaxie 500XL hardtop with a 3.1:1 axle and a modest 330 horsepower:

0-60	8.5 seconds
0-100	22.1 seconds
40-60	4.1 seconds
50-70	4.7 seconds

A Falcon Sprint with a four-speed manual transmission, a mere 164 horsepower and 3.5 axle:

0-60	11.8 seconds
0-90	29.0 seconds
40-60	4.5 seconds
50-70	7.5 seconds

Ford has many "tremendous trifles" for '64. Among them is a retractable seat belt that will be used by almost all the cars in the industry. Manufactured by the Spring Division of the Borg-Warner Corp., it can't lop over the sill and get caught in the door. It doesn't clutter the seat when not in use. It doesn't get lost on the floor.

By brands, here's some of the news of Ford announced last month.

Galaxie Preoccupied, like every other auto maker, with styling, Ford has given its top car a new body. Performance not withstanding, the Galaxie's thunderous 427-cubic-inch engine will be phased out during the model year to come inside the 396-inch limit decreed for 1964 by the National Association for Stock Car Auto Racing.

Galaxie convertibles have a flexible-glass rear window that won't scratch or

[*Continued on page 215*]

A child was the original cause of that left-handed ignition key

One day in 1952 Lewis Crusoe, then general manager of the Ford Division, was driving in heavy traffic with a grandchild on the seat beside him.

The moppet reached over and turned the ignition key on the right side of the steering wheel. The engine quit.

Lew Crusoe got to thinking. If small fingers could turn the key off, they could turn it on. It was a dangerous location for an ignition key. He issued orders that henceforth his cars would have their keys on the left of the steering wheel.

There they remained on Ford products until the 1964 cars were designed. Now they are back on the right side of the wheel.

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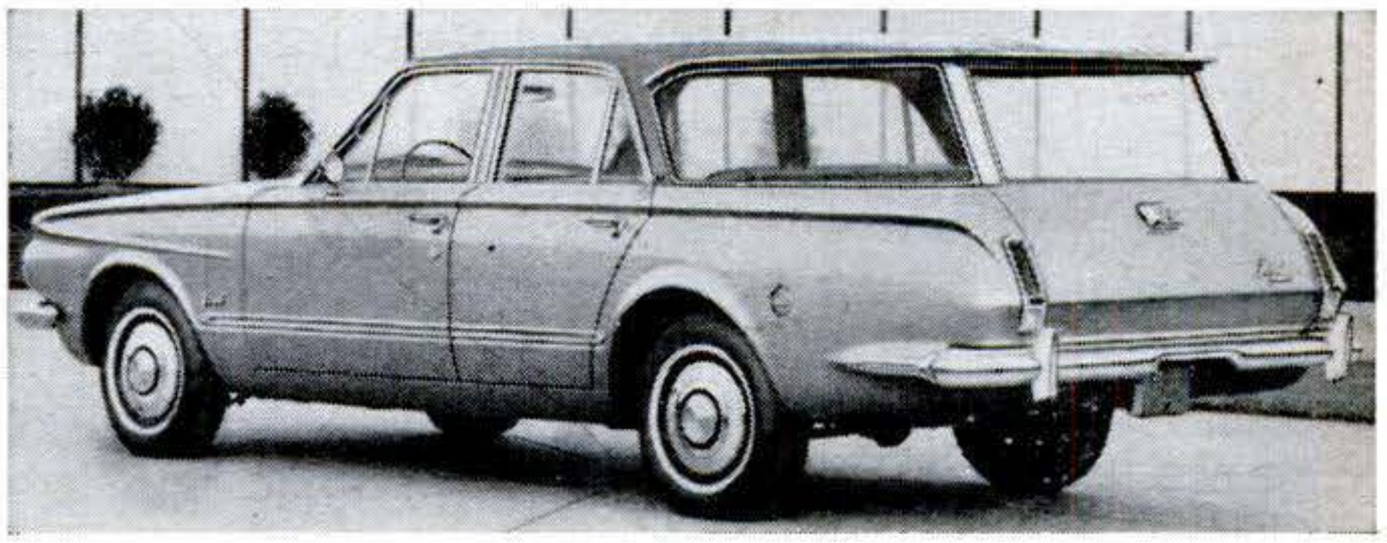
What's new at Chrysler Corporation

- a huskier four-speed transmission
- a detuned 426 V-8 for the masses
- new styling for Imperial and 880
- a rag top for the 300-K
- service-free crankcase ventilation

New engine, transmission

Chrysler's line combines greater dependability, performance, and luxury, and offers a wide variety of options

IT WAS sure that the Imperial and Dodge 880 would be restyled completely. They were long overdue. Also predictably, the bread-and-butter cars of the Chrysler Corp.—the Valiant, Dart, Plymouth, and Dodge—and also the Chrysler series, got only a face-lift. They had had their date with the restylists in 1963.



Valiants have changed little. Above: '64 V-200 wagon.

As has been typical of the corporation in recent years, a number of detail improvements have been introduced across the board. These include: an improved, nonsticking choke; greater engine splash shielding; self-cleaning crankcase-ventilation valve (a spring-loaded plunger inside the valve is constantly in motion, thus reducing deposits in the orifice); stronger door latches; more efficient air conditioning (which is optional).

CONTINUED

Luxury convertible below, like all Imperials for '64, has been completely restyled.

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All the lines except Imperial offer a new Chrysler-built four-speed floor-shift gearbox that's synchronized in all forward speeds. It's huskier than the previously used Borg-Warner box, and can take the torque of the 426 superstock V-8s. It can be ordered with sixes, too.

There's also a detuned, or street, version of the 426—with tighter clearances and less radical valve timing—that can be ordered on Plymouths and Dodges. Though horsepower figures aren't available at this writing, 375-385 is a good guess. Compression ratios of all sixes are increased slightly for better economy.

Full-size Plymouths and Dodges have a two-inch-wider rear track (for better looks, greater stability) and one-inch-longer rear leaf springs (for greater durability).

The TorqueFlite automatic transmission is improved in every line; it now has an internal oil filter. The three-speed manual box is sturdier.

High-performance bucket-seat models of the Plymouth, Dodge, and Chrysler offer a console-mounted shift lever for the TorqueFlite, instead of the customary buttons.

To get back to the luxury jobs: Chryslers and Imperials offer optional adjustable steering; the wheel tilts to seven positions.

The Chrysler 300-K has switched to a softer suspension, but offers the firmer springing optionally. More news: A 300-K convertible is now available. ■ ■

Dodge's racing motto: "Our day will come"

There's a silently hopeful reminder taped over the tachometers of the 1963 Dodges driven in NASCAR stock-car races by Dave Pearson and Billy Wade: "Our day will come." Though Ford reigned supreme at the start of the season, the Plymouths, running engines identical to the Dodges, have turned hot recently, winning consistently, especially on the shorter tracks. Dodges came close several times, but have had bad breaks.

Pearson and Wade are betting on who'll change the motto to: "We did it!"

What's new at Studebaker

- greater length
- new styling
- new engine

Studebaker: An all-new Lark

Heavy sculpturing sets off new Studebakers.

THE tired old styling of the Studebaker Lark is no more. The car has an entirely new body.

Lengths of the Challenger, Daytona, Cruiser, and newly introduced Commander are up six inches. The four-door Wagonaire has grown three inches. The Commander, reviving a nameplate nearly three decades old, is now the second-lowest-priced Studebaker.

The Challenger and Commander series alone retain the Lark designation, although the Daytona and Cruiser lines still use the same basic shell. And they alone offer sixes as well as V-8s. The Hawk is face-lifted. Avanti continues unchanged.

The engine lineup is basically the same. New is a 304.5-cubic-inch V-8 without blower.

Minor changes on the sixes: limited-

[*Continued on page 230*]

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What's new at Pontiac

- 44 different engine choices
- a wholly new Tempest
- fresh styling in "big" cars
- softer body mounts
- front-end grease fittings

Pontiac: power options

"Retired" stock-car champ now sports a body-frame cushion of special "putty" rubber that has no rebound

THE biggest source of engine options for domestically manufactured automobiles—based on a supply of standard camshafts, carburetors, and compression ratios—is GM's Pontiac Motor Division. For 1964 Pontiac offers no less than 37 options in its big line of cars; and seven for the smaller Tempest.

This is traditional with Pontiac. The multiple choices proliferated during the years that this car monopolized the winner's circle at stock-car racetracks. Now, officially at least, Pontiac is no longer competing.

Like all standard Pontiacs, Bonneville, on 123-inch wheelbase, is an inch longer for '64. Significant design change: universal joints free of vibration.

Overall, horsepowers run from a modest 140 to 370. Horsepower on the company's 389-inch engine with automatic drive is up from 313 to 330; that on the same engine with synchromesh from 303 to 306.

The '64 Tempest is wholly new, with a 215-inch six-cylinder engine replacing its four-cylinder. The bigger Pontiacs are restyled. Softer body mounts insulate passengers from road shocks. In Pontiac's engineering shops the rubber used is so insensitive to rebound that it's called "silly putty."

While the Tempest boasts a 12,000-mile lubrication period for its front end, the car owner is saved the expense of having a mechanic attach grease fittings —they're factory-installed.

Pontiac discovers that customers in the wide-open spaces want some oomph

Every 10 days throughout the year Detroit's automobile factories receive and study sales reports collected from all over the land. Sales reports on the Pontiac Tempest in its 115-horsepower, four-cylinder version weren't good during the 1963 model year. So, for 1964, it's dumped.

"Funny thing," ruminates Pete Estes, Pontiac's genial general manager. "That engine sold pretty well in the metropolitan areas of the east and west coasts, but not in the wide-open spaces in between. There they want performance."

Replacing the four is a spanking new six-cylinder in-line engine of 215-cubic-inch displacement and 140 horsepower.

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What's new at Buick

- more miles per gallon
- transmissions
- an engine
- bigger "Special"
- two-ply tires

Buick: Economy plus scat

Shrewd engineering has produced lower car weights, higher horsepowers, and more efficient automatic drives

IN DESIGNING automobiles, engineers generally have to choose between performance and gas economy. For 1964, Buick has engineered one wholly new engine and reworked an existing one, and strange to relate they managed to get both performance and gas economy from each. This, despite the fact that the engines produce substantially more power than the ones they replace.

Behind this are three factors: lower engine and car weight; more efficient transmissions; and lower axle ratios.

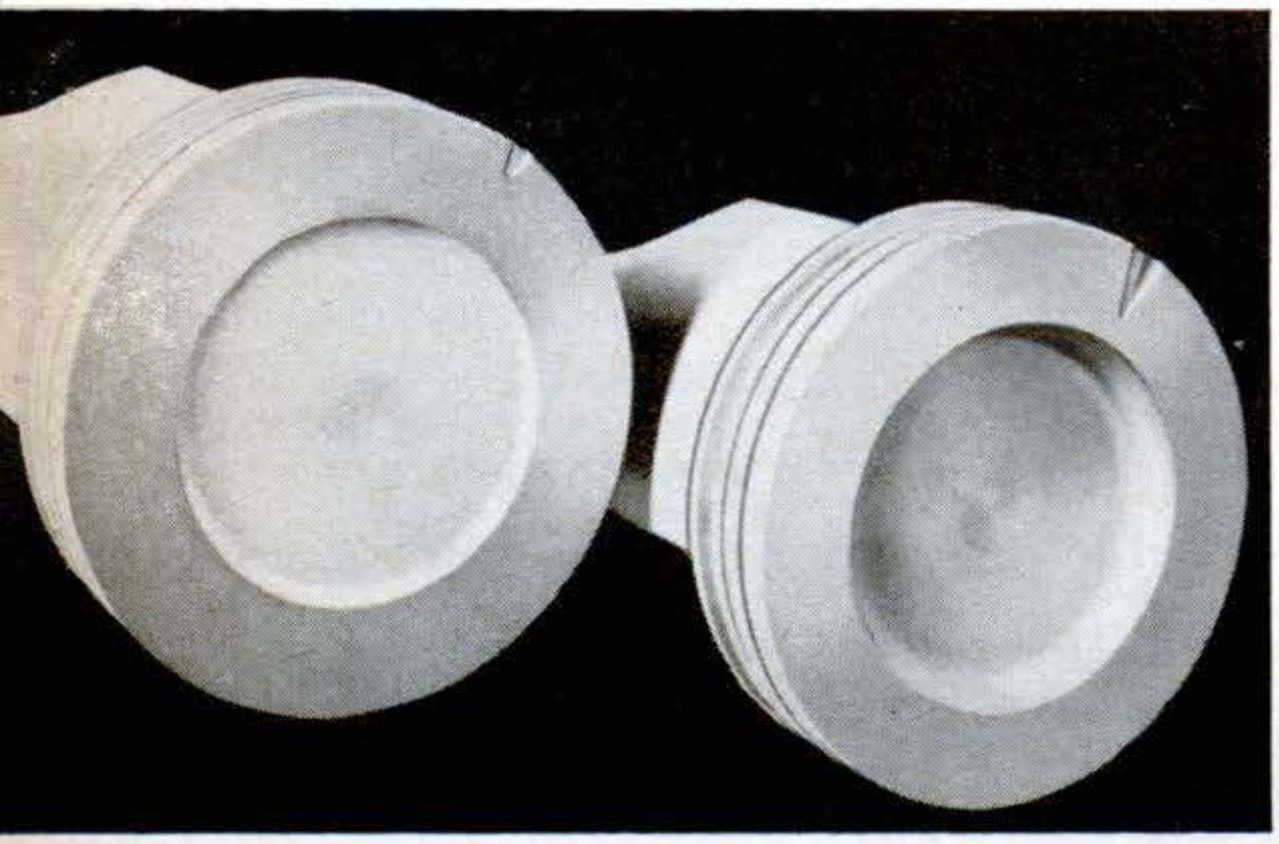
A total of 330 pounds, for instance, has been scissored off the LeSabre model, Buick's lowest-priced standard-size car, fitted with an automatic transmission and the new engine. About 95 pounds is due to weight-saving in the engine.

Buick's V-6 weighed 1.86 pounds per cubic inch of piston displacement in 1963. For '64 it weighs only 1.68. A 1963 V-8—made of aluminum, mind you—weighed 1.49 pounds per cubic inch.

[Continued on page 230]

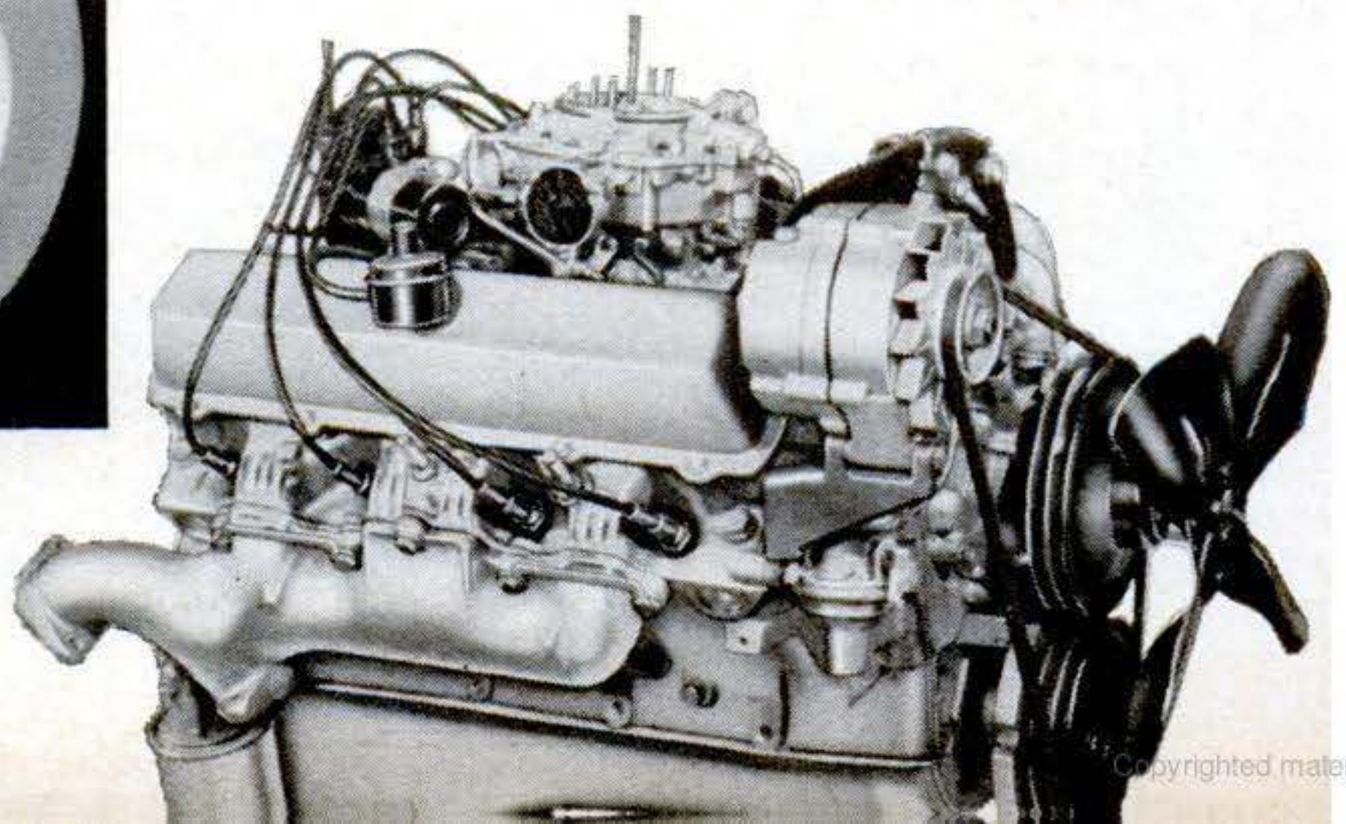
What's new at Olds

- new body for F-85
- larger, cast-iron V-8
- two new models



New OHV V-8 comes in 210-260-hp. packages. Compression ratio is governed by depth of circular depression in piston crown. At left, piston from Rocket H.C. engine with 10.25:1 ratio; at right, 8.75:1.

NO LONGER making any pretense of being a compact car, the 1964 Olds F-85 lacks only a foot of being as long as the standard Oldsmobile sedans. It has company—at 203 inches: It's exactly as long, bumper to



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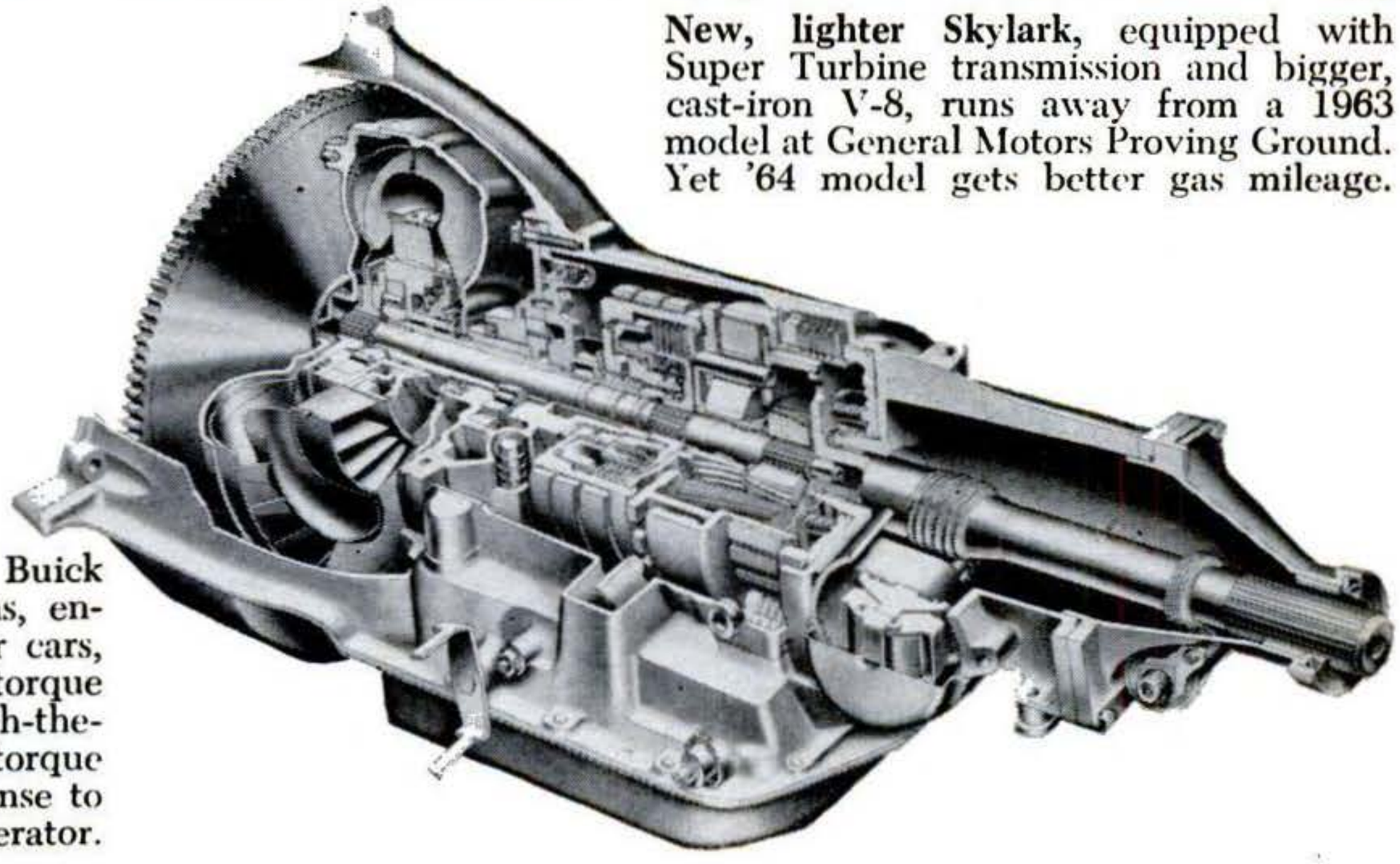
New, lighter Skylark, equipped with Super Turbine transmission and bigger, cast-iron V-8, runs away from a 1963 model at General Motors Proving Ground. Yet '64 model gets better gas mileage.



Smaller of the two Buick automatic transmissions, engineered for its lighter cars, is the ST-300. Its torque converter has a switch-the-pitch stator to vary torque multiplication in response to pressure on the accelerator.

Olds offers performance, variety

bumper, as the new Buick Special and Pontiac Tempest. For the F-85, that's a gain of 11 inches, and adds to 4.2 inches tacked on for 1963.

Other significant changes have been made in this car. The turbocharged engine is dead, or, as the Olds management euphemistically put it, "deferred."

Also deferred: a station wagon with a raised windshield like the astrodome on railroad coaches and Greyhound buses.

[*Continued on page 207*]

Fancier trim sets off sporty Jetstar I from the Starfire. Cars are identical mechanically.

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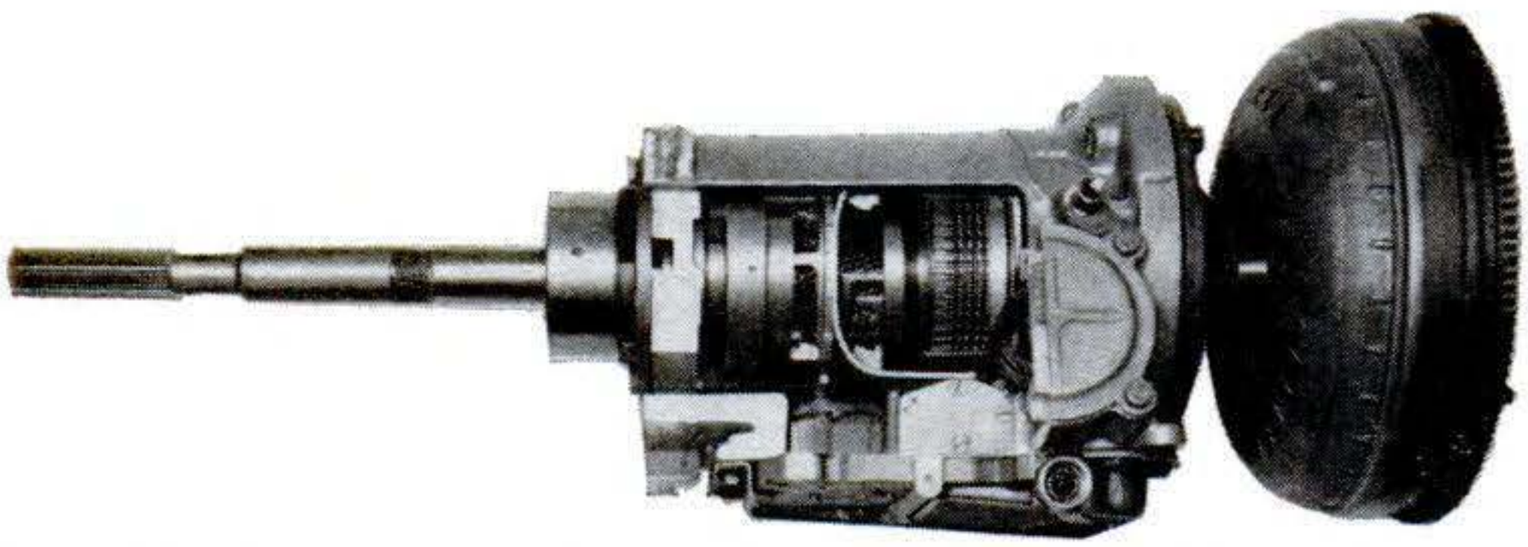
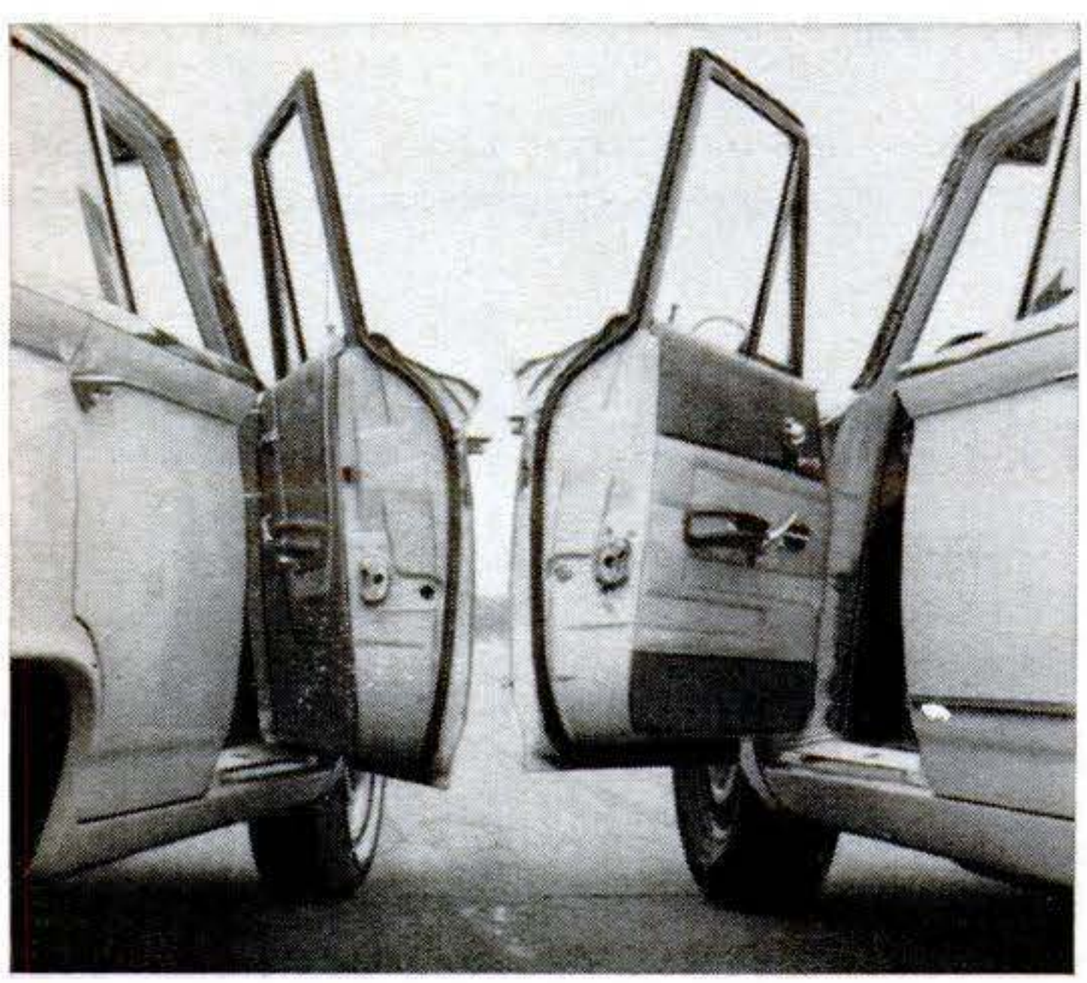
What's new at Lincoln-Mercury

- softer rides
- a bright-star Comet
- a Mercury engine
- a bigger Continental

Extra, extra— the fight results



New three-speed automatic transmission has dual-range feature permitting a lockout of low gear for less torque in starting up on ice or snow. Drive has torque converter, two sets of gears.



AT LINCOLN-Mercury, an annual fight occurs between engineers who want a stiff suspension and sports-car handling—they won out for '63—and those who want a soft ride. For '64 the squabble ended in a compromise.

The most exciting news in this segment of the Ford empire is the Comet, wrapped in an entirely new body. But Mercury boasts a new engine, and the Lincoln Continental more interior room.

Comet A three-speed automatic drive replaces 1963's two-speed. There's a new 210-hp. V-8 engine and a 116-hp. six. For the first time, Comet has optional power brakes. Frame and suspension are brand-new. Comet's brightest star is a sporty model, the Caliente.

Mercury A new 390-cubic-inch V-8 turns out 330 hp. Carburetor improvements provide better cold starts and save gas. The Meteor line is dropped. A rubber-insulated power-steering pump is designed to reduce vibration.

Continental Three inches longer, this luxury car provides more room inside. Rear doors are three inches wider.

Entrance to Mercury is easier—less ducking and bending—because '64 door sill is 1.3 inches higher and car an inch taller overall. Picture above shows comparison. At right PS Auto Editor Francis displays new Mercury and first of breed, produced in 1938. It had a 95-horsepower engine.

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What's new at Rambler

- "unisides" for American
- extended lube intervals
- manual-shifting automatic

A spanking-new American

Lots of small improvements in all three lines make the cars prettier, safer, easier to drive, and less trouble to service

THE little Rambler American, shortest sedan built in this country, has captured the limelight at American Motors this year. Like the Classic and Ambassador, it now has one-piece uniside construction—and new body styling. Wheelbase is up six inches, to 106. Leg room at rear is up 12 inches. Yet overall length (177.3) is only 4.2 inches greater.

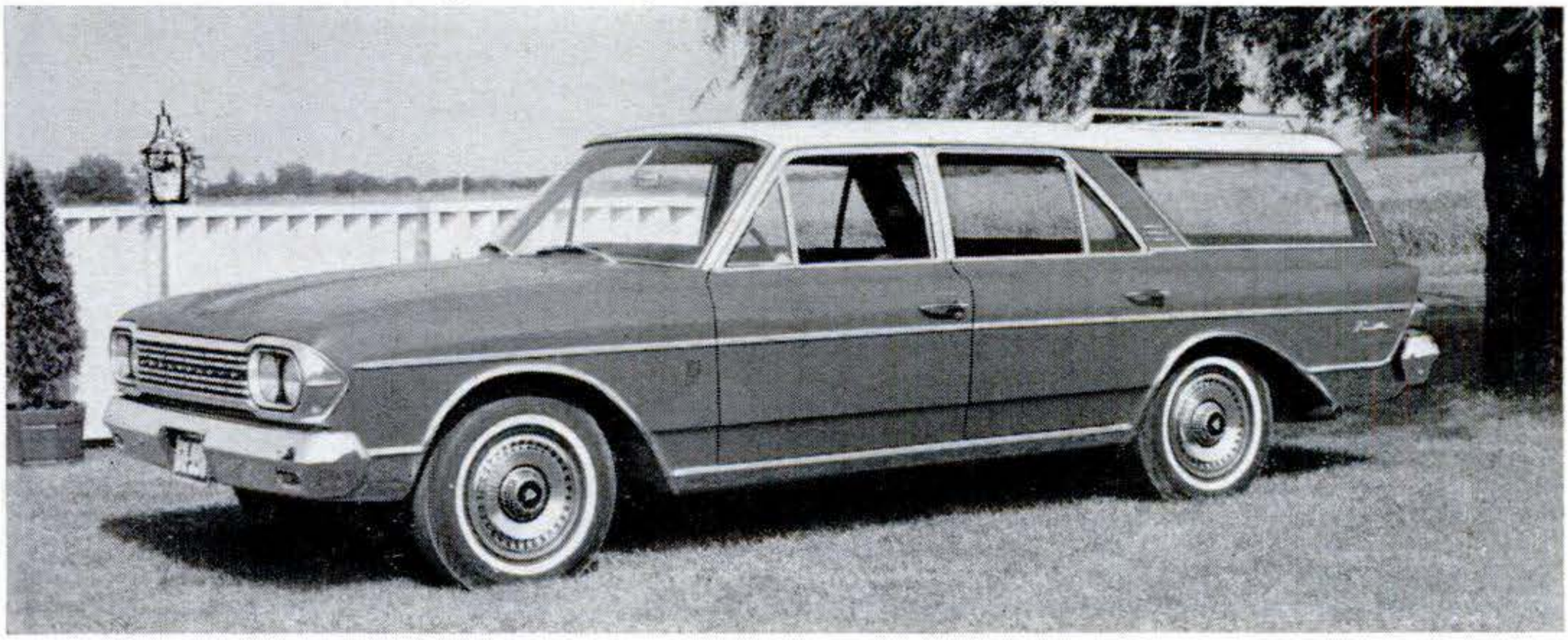
There's a lubricated-for-life front suspension and seven-inch-longer rear leaf springs. The rest of the suspension needs grease every 33,000 miles or every three years. Manual steering is slower (ratio increased from 22.3:1 to 24:1) and the new power steering is faster (reduced from 20:1 on Classic and Ambassador, and 22.3:1 on American, to 17.5:1 on all models).

Classic comes in 10 models. Shown here is the hardtop.

Windshield area on the American is up 32 percent. The Classic and Ambassador have been face-lifted. A new "Shift-Command" three-speed automatic transmission—optional on bucket-seat V-8s—can be shifted manually, if you desire.

Engine line-up remains the same—from a 90-hp. six to a 270-hp. V-8.

Face-lifted Ambassador wagon offers optional third seat. Last year's 880 has been eliminated.



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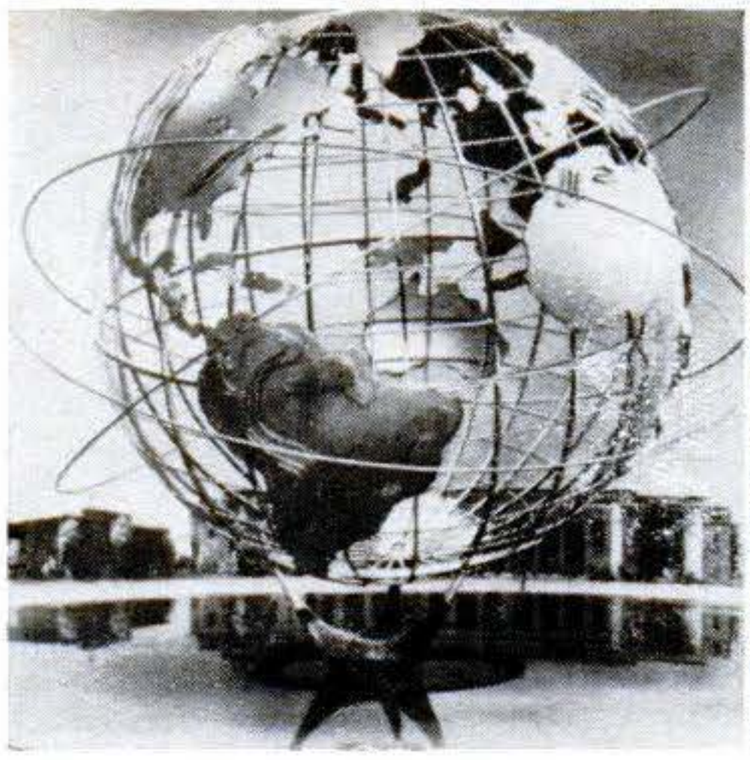
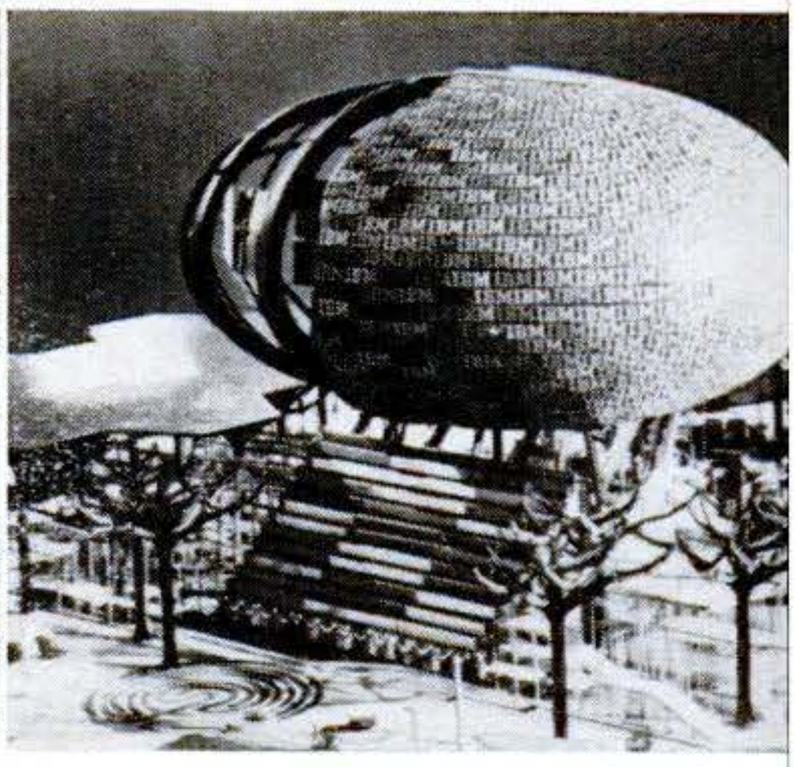
And here's the World's Fair as it will look

Backgrounds of the portraits of the '64 cars that you have seen at the start of the annual POPULAR SCIENCE Auto Section show the New York World's Fair buildings abuilding. Here you see them as they will look when the Fair opens on next April 22. They will be situated in the Transportation and Industrial areas. In all, there will be 60 buildings, more than 200 exhibitors—a billion-dollar fair, served by a new network of highways costing $129,000,000.

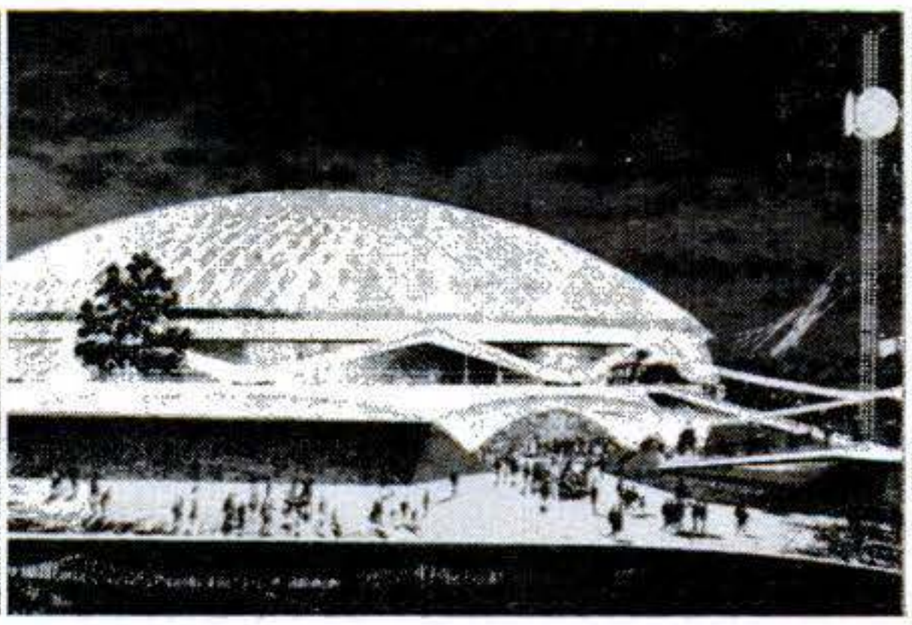


Theme: the world, or Unisphere

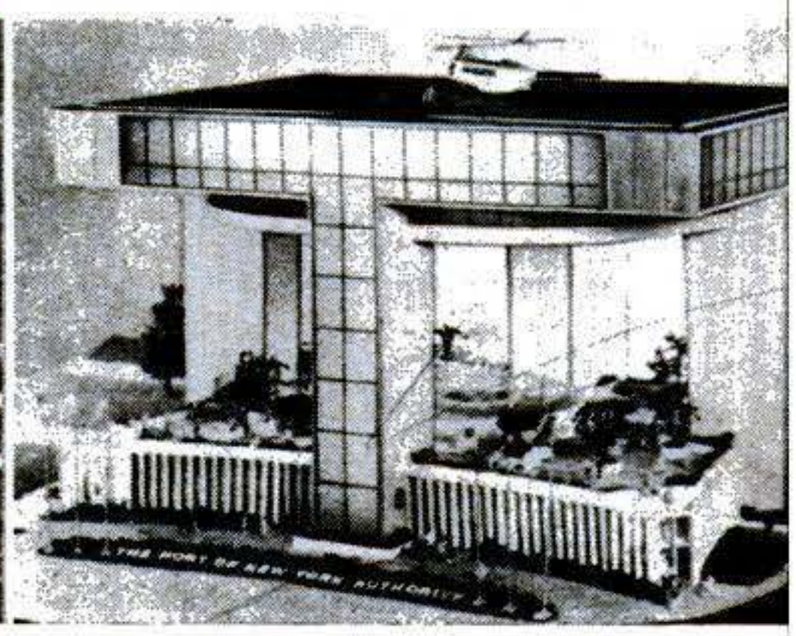


International Business Machine

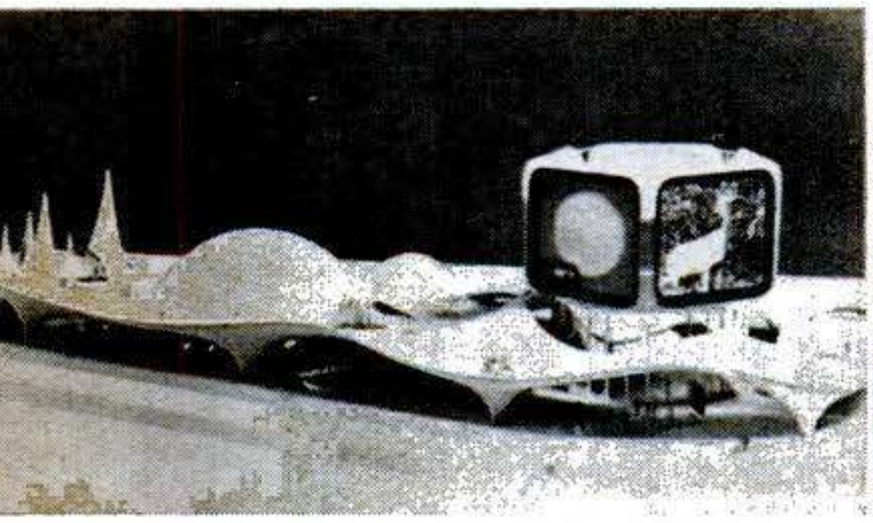
Ford Motor Co.



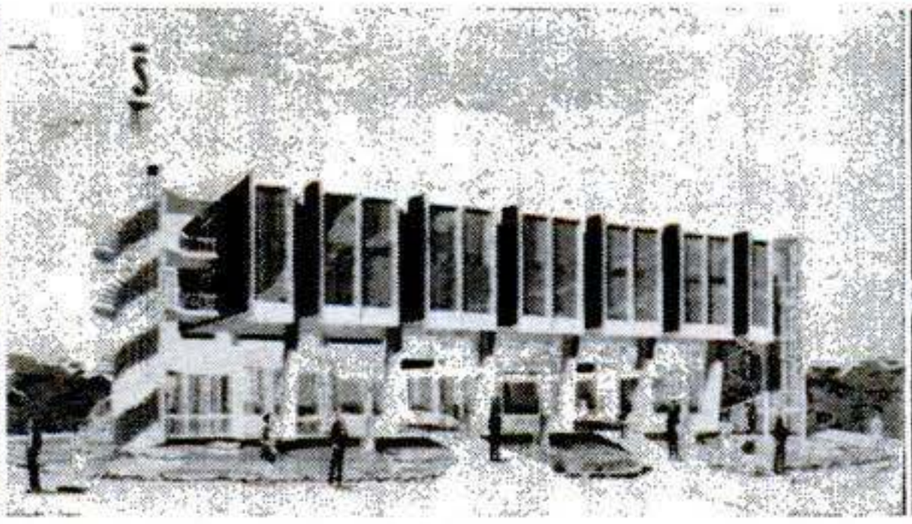
General Electric Co.



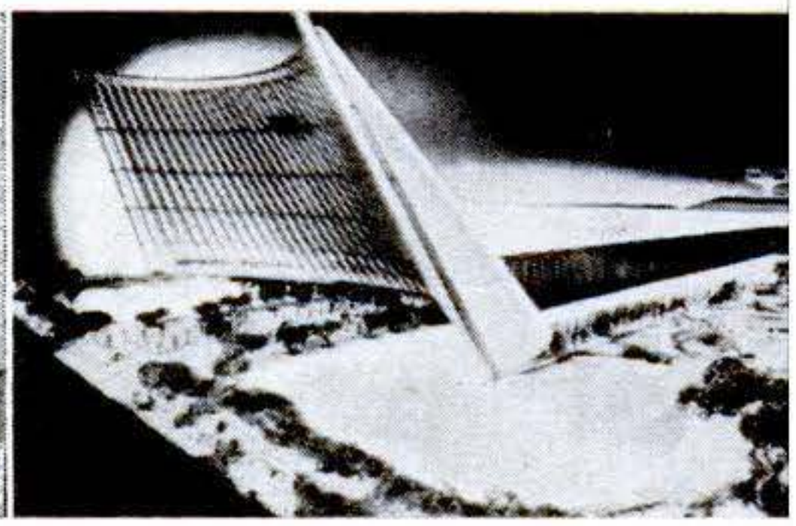
New York Port Authority



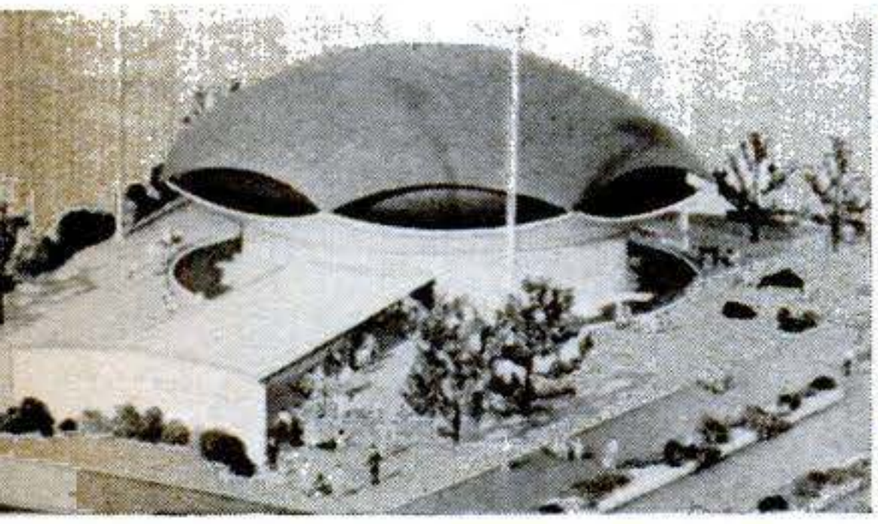
Eastman Kodak



Simmons Mattress

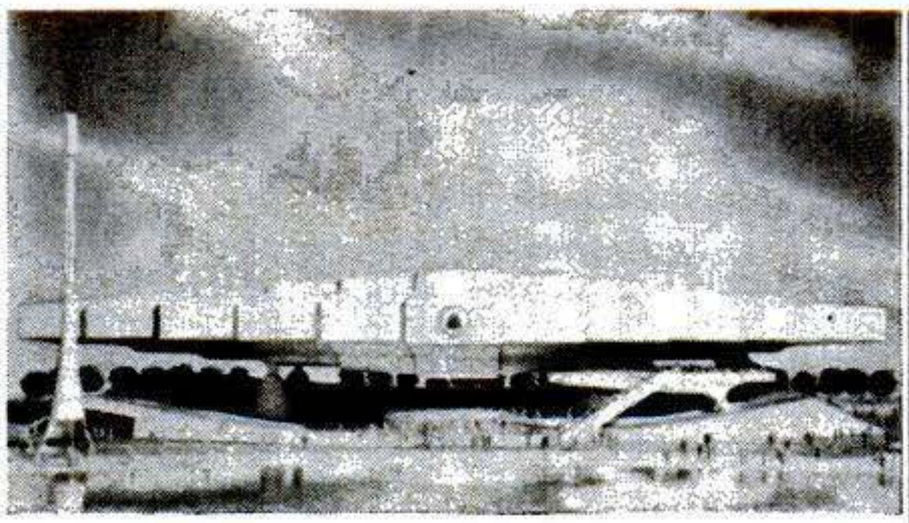


General Motors Corp.



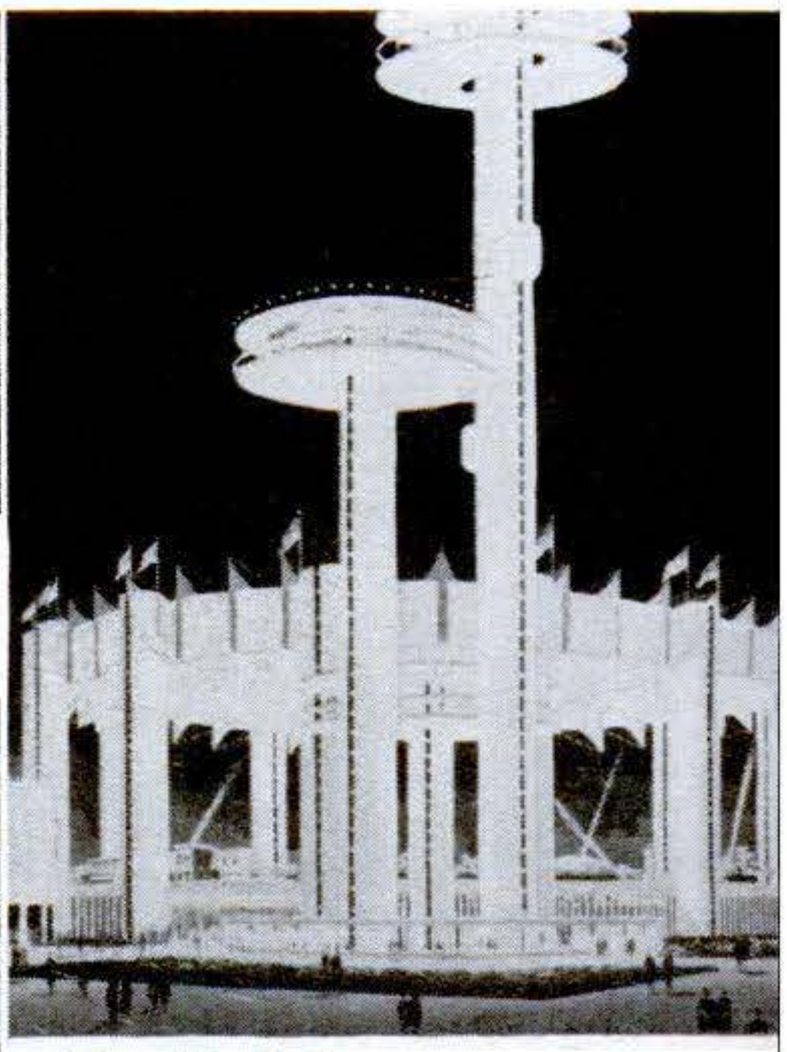
Traveler's Insurance

Shea baseball stadium



Bell System

Gas Industries



New York State

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Life or Death

The woman is unconscious, not breathing. You're first on the scene. Would you know how to bring her back to life?

The victim's head is tilted back so that the airways to the lungs are open. First-aider blocks off the nostrils, takes a deep breath, and blows air into the victim's mouth. His mouth must completely cover the victim's, otherwise no air will get to the lungs.

THE man on the right is demonstrating mouth-to-mouth breathing, the method of resuscitation the Red Cross now recommends.

At the start of the cycle the man takes a deep breath. His fist is under the girl's neck, forcing her head to drop back and her jaw to tilt up. This opens the air passages from mouth to lungs. At the same time, his index and middle fingers block off the nostrils so that no air can escape that way.

Bottom picture shows him blowing air into the girl's mouth. Her chest rises as the lungs fill with air. There's only one thing

To see how patient responded, turn the page

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Poor Annie

Anne's head and shoulders are weighted to match an adult's. At start of breathing cycle the lungs are collapsed, hidden under the plastic chest. They present the same degree of air resistance as the lungs of an unconscious person.

Air blown into mouth of doll flows down windpipe, through a valve and into lungs to inflate them. The action is exaggerated here. Normally breaths are controlled so that there is no danger of internal damage to chest or lungs of the victim.

peculiar: *She's not real.* She's Resusci-Anne, a Norwegian-made inflatable doll.

The lifesaver is Capt. Austin Brady, of the New York Shipping Association's Safety Bureau. He's been using Annie to teach resuscitating techniques to longshoremen at New York docks.

The ski-outfitted Scandinavian blonde is more than just a dummy, however. Her head and shoulders match the weight of an adult. Her skin feels real, and she has a throat-trachea-and-lung system whose capacity and air resistance approximate an unconscious person's.

When air is blown in, the collapsible lung sack under her plastic chest inflates. On the exhale, air is trapped by a bypass valve and vented off through the doll's neck—a hygienic precaution.

The ingenious design permits first-aid students to master mouth-to-mouth breathing. One reason the Red Cross favors the method: The carbon dioxide in human breath primes nerve centers in the victim's brain that can start him breathing normally. ■ ■

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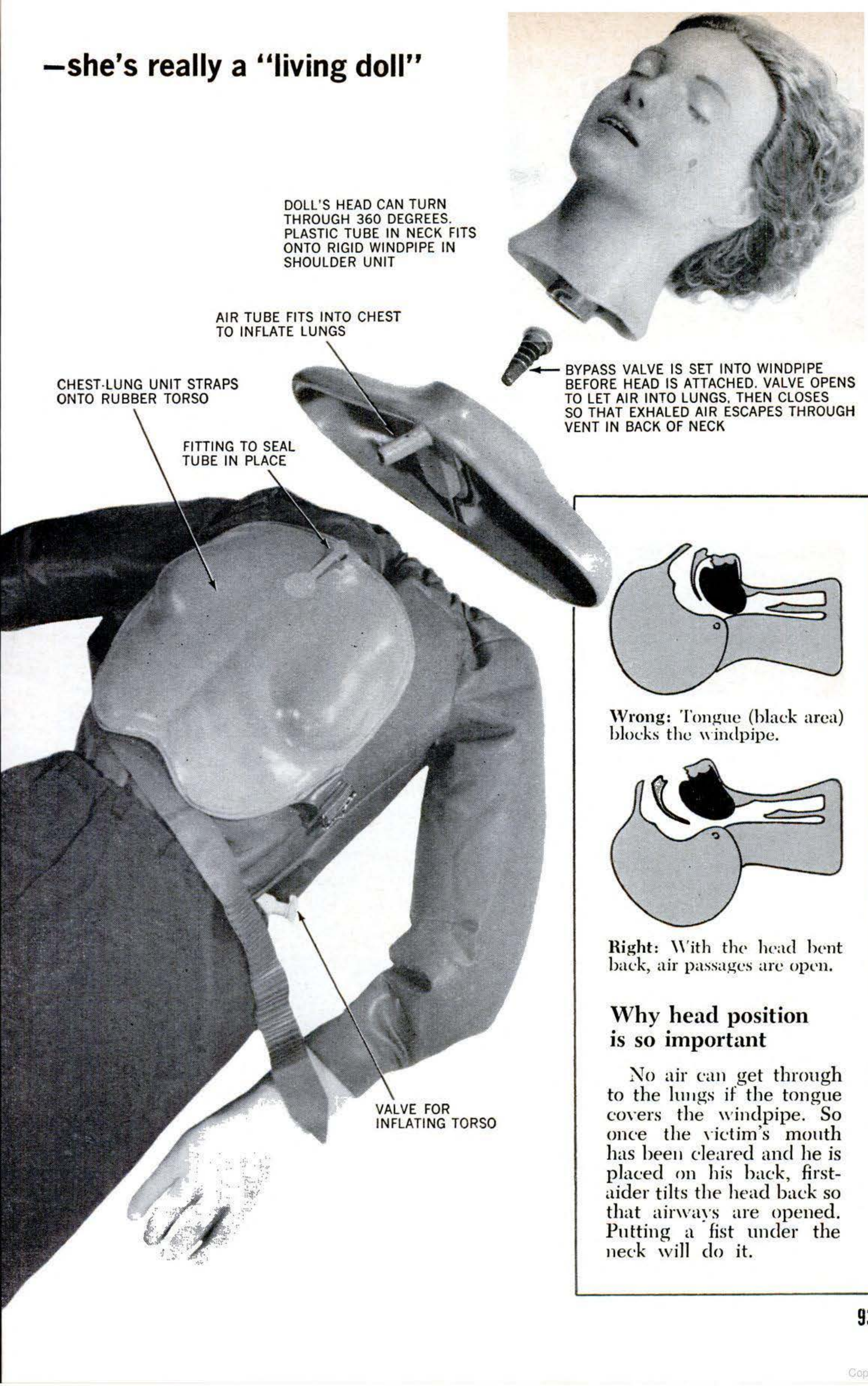
—she's really a "living doll"



Wrong: Tongue (black area) blocks the windpipe.

Right: With the head bent back, air passages are open.

Why head position is so important

No air can get through to the lungs if the tongue covers the windpipe. So once the victim's mouth has been cleared and he is placed on his back, first-aider tilts the head back so that airways are opened. Putting a fist under the neck will do it.

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FROM ENGLAND:

First Home TV Tape

No longer years off, budget-priced video tape recording will reach U.S. viewers next year

By David Scott, *PS European Editor*

TAPE revolutionized TV broadcasting. Now it's going to revolutionize TV watching.

The first video tape recorder for home use will hit the American market next year. Developed in England, it will cost only about $175 for a tape deck to plug into your own TV set. As a built-in unit added by the set manufacturer, it will add only 25 percent to the price of a TV receiver. An American manufacturer has already agreed to produce the device in this country.

Uses are easy to imagine: Tape the best shows and play them back whenever you want. (You can stop the machine during commercials or edit them out later.) Have your wife tape the afternoon ball games for viewing when you get home.

It may also become possible to record one show while watching another, if dual tuning circuits are included in the combined TV set and recorder.

The same machine can be used to make your own original TV shows at home—instant home movies. A miniature video camera and a microphone will let you put image and sound on the tape, to be played back immediately on your TV.

This exciting breakthrough comes from the Telcan Company, a small electronics firm in the sleepy English village of East Bridgford, Nottinghamshire, where I saw the system demonstrated.

"Breakthrough" is the right word. Commercial video recording has been around for some years, of course, but the equipment costs several thousand dollars and up. Why? Although the principle is the same as recording sound

CONTINUED

Taped image, right, is far from ideal. Ultra-hi-fi tape is expected to improve quality.

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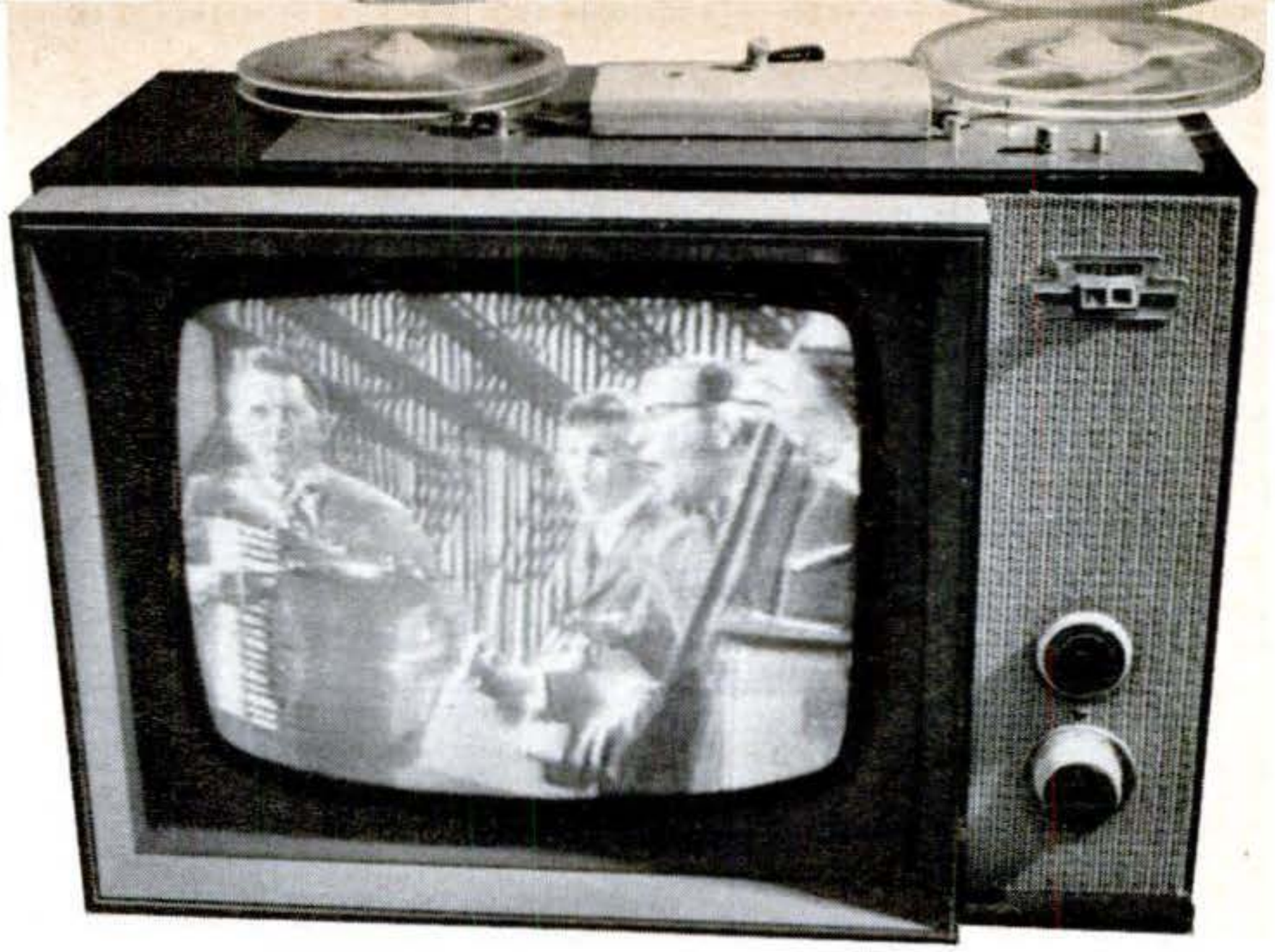
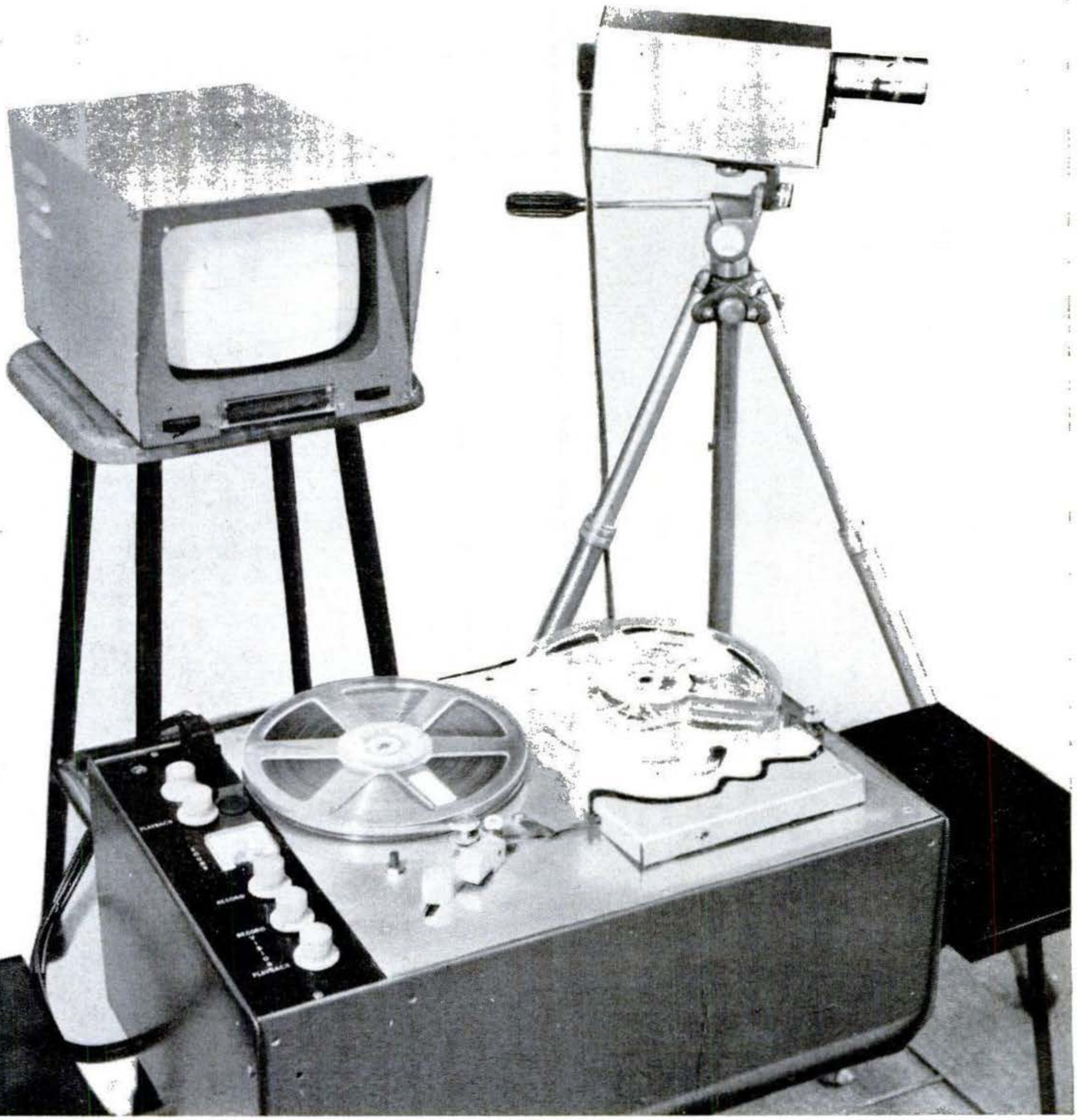
Recorder

Video tape unit will be available in two ways: built into TV set, as at right, or as a tape deck—shown below in "instant home movie" outfit, which also includes low-cost TV camera, small monitoring screen. Picture playback is immediate.





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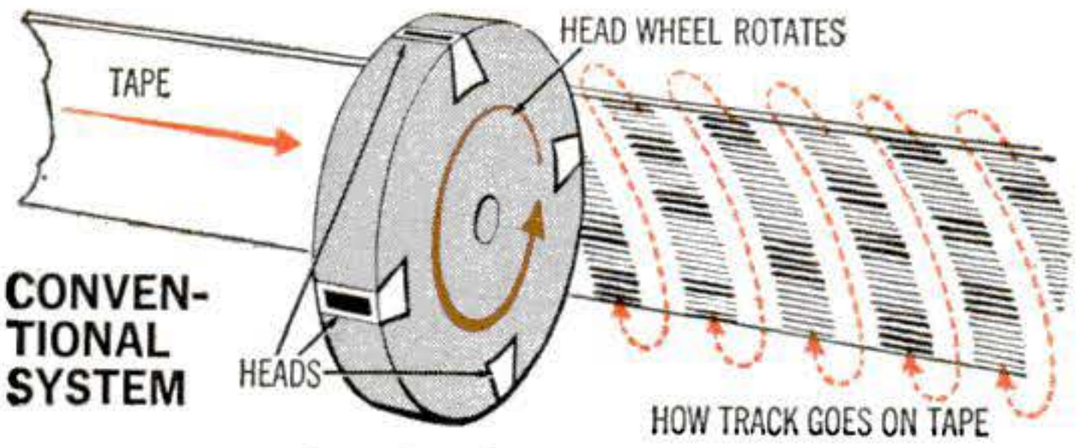
Will this new U.S. TV tape system be better?

In this country, a man named Marvin Camras is working hard at Illinois Institute of Technology to develop a new and ingenious method of video tape recording that will yield tapes of professional quality at reduced cost. Camras has been responsible for many of the major advances in audio tape recording.

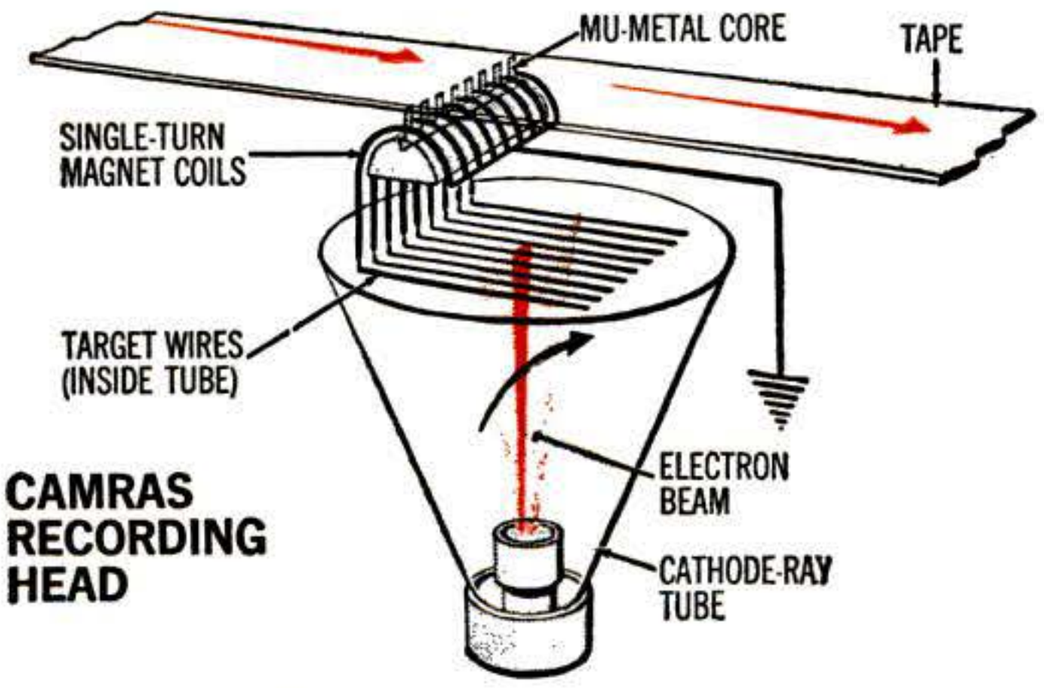
His approach is to record the same kind of track on the tape as that made by the conventional system—which uses



CONVENTIONAL SYSTEM

a rotating head that moves across the two-inch-wide tape as it zips past (see sketch)—but without a moving head.

The Camras system uses 250 tiny recording heads stacked down the width of



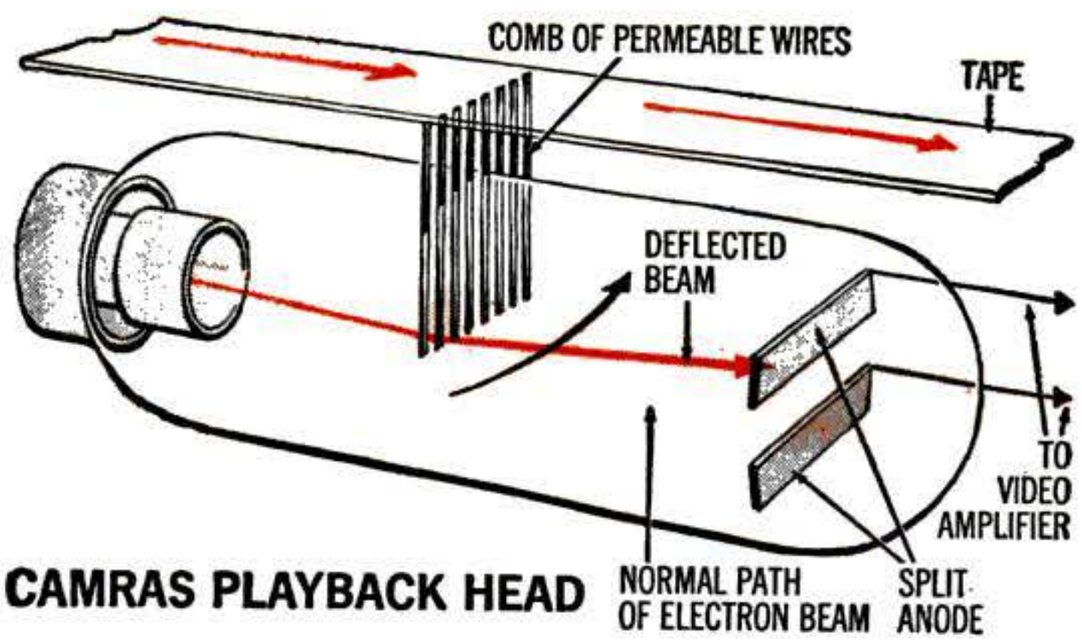
CAMRAS RECORDING HEAD

the tape. The video signal is fed to only one microhead at a time, with rapid switching so that the heads are energized in sequence.

The heads are actually formed by 500 loops of tungsten wire fitting in slots in a sawtoothed core of mu-metal (a nonmagnetic metal). Each tiny sawtooth serves as an electromagnet's air gap, making each pair of wires act as an individual recording head.

To get near-instantaneous switching along the row of microheads, the tungsten wires pass through the face of a cathode-ray tube. An electron beam carrying the video signal sweeps across this target of wires, energizing each pair of wires in sequence.

For playback, a different kind of tube head is used. The tungsten coils are replaced by a comb of "permeable" (easily magnetized) wires. This comb contacts the tape and protrudes through the tube envelope. The wires thus transmit the magnetic field from each line of recording into the tube.



CAMRAS PLAYBACK HEAD

This field deflects an electron beam as it sweeps across the comb, making it bounce either upward or downward, depending on the polarity of magnetization of each wire. The ray thus hits one of two anodes—positively charged plates. A signal pulse is generated when it hits either anode, and this train of pulses makes up the video signal.

A tape deck equipped with both kinds of tube heads is a complete recording and playback tape system.—*Art Zuckerman.*

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on tape, the band width for a picture signal is 3 to 4 million cycles, as against 10-15,000 cycles for sound. That many more impulses per second must be squeezed onto the tape.

While a sound-tape deck need run at only seven inches per second for acceptable fidelity, video recorders have to hustle the tape past the magnetic head correspondingly faster to keep up with the high-frequency signal. Machines for broadcast work use a rotary four-pole head, spun at 3,000 r.p.m. *across* a two-inch-wide tape skidded at 15 inches per second past the head.

This combination produces a track on the tape consisting of parallel oblique lines that give the required head-to-track speed in compressed form. But

[*Continued on page 208*]

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'Stupid' Questions About HEREDITY

BETTMANN ARCHIVE

By Martin Mann

THE one science that most critically affects people in their everyday lives is one that most people confuse: heredity. Some worry needlessly about passing on disease to their children; others neglect precautions that might prevent tragedy. Mistaken notions about heredity underlie today's flaming racial conflicts, and even influence the cold war: Russia's failure to produce enough meat for her population can be blamed on her tardy development of hybrid corn for cattle feed. This in turn may be blamed on Communist distortions of the science of heredity.

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You can be pretty sure that you're unique. The odds that

Yet while experts sometimes disagree on conclusions, few dispute the basic facts of heredity:

Why do the kids look like me and the wife?

That's heredity. Every cell in your body contains a complex chemical, deoxyribonucleic acid [See "DNA: It Calls the Signals for Life," PS, May], which makes up the dies to stamp out one particular human being—you. The DNA is arranged in pairs of units called genes, strung into longer paired bundles called chromosomes. There are 46 chromosomes —23 matching pairs—in most cells in your body. The exceptions are the sex cells: Each egg or sperm cell has exactly half as many—one chromosome from each pair. When a child is conceived, it gets one of these half-sets from pa and one from ma. So the child's cells—with their built-in pattern of development—are set by the parents' chromosomes.

Then how come some boys are exact images of their fathers? Their mothers don't figure in at all.

The answer is still the genes. A single chromosome pair that a child inherits is made up of either one of pa's paired genes combined with either one of ma's. But often in gene pairs, one may dominate—that's the one that will set the working pattern. If a child inherits most of his dominant genes from his father, he'll be a chip off the old block.

Only two possibilities for pa's gene and two for ma's sounds like they could have only four different kids.

Uh-uh. Don't forget that's just one gene out of many thousands that lie on the 23 pairs of chromosomes. These pairs split to form the sex cells and recombine at conception in vast numbers of ways. The possible combinations add up to 8,388,608. And that's just chromosome combinations. The number of ways the genes themselves can cross over and line up are incalculable.

What about identical twins?

They result from a division of a single egg *after* it has been fertilized—after pa's and ma's genes have combined.

Then identical twins are absolutely alike?

Only in heredity. Sometimes the egg that produces them divides into right-hand and left-hand halves. Then the twins look like mirror images rather than carbon copies—if one is short a tooth in the right side of his jaw, his twin will lack the corresponding tooth on the left. Anyway, heredity furnishes only the raw material for a person. The finished product is the result of many other factors.

Are identical twins always of the same sex?

Yes, because sex is determined by the combination of two particular packages of genes—the X and Y chromosomes. Female sex cells always contain the X chromosome. Male sex cells contain either X or Y. If, at conception, the X from mom combines with another X from pop, the child will be a girl. If an X combines with a Y, it's a boy. This combining of chromosomes occurs *before* the egg can divide into identical twins.

What about nonidentical twins?

They're more common in America. They result when *two* eggs happen to get fertilized at the same time. Since two different eggs and two different sperm are involved, their chromosome combinations are no more alike than those of any other brothers or sisters in the same family. They can be the same sex or opposites.

If there are twins in my family, will I have twin children, too?

Maybe. The chances of having fraternal twins appears linked to an inherit-

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ed tendency of some women to produce more than one egg at a time. But *all* women also show a natural tendency to produce more than one egg as they grow older—reaching a peak at 37 years.

Age does not seem to be a factor in identical-twin bearing, however. Some authorities think the process is completely random. But there are too many instances of identical twins having identical twins to rule out the factor of inheritance via both father and mother.

Does the system for transmitting heredity always work right?

No. Just about anything that could go wrong sometimes does. Only recently physicians have discovered that some people are born lacking one of the sex chromosomes or with one or more too many. They are mixtures of both male and female.

Are diseases inherited?

The list is long and gruesome, running from certain kinds of anemias and mental retardation to shrinking bones and harelip. But the evidence is not always certain. Rickets, for example, was long blamed on heredity. It clearly ran in families. When doctors finally discovered that it was caused by a poor diet lacking vitamin D, they realized that it was poverty, not rickets, that was inherited.

What about cancer? Heart disease? Mental illness?

In some pure-bred strains of mice, susceptibility to cancer is definitely inherited. In people, the evidence is not clear-cut, although it seems that a tendency to all these diseases can be inherited.

How are diseases inherited?

Through the genes. In a sense, they're the programers that determine the body's chemical processes. If there's an error in the programing, the product is imperfect —there's a part that's not up to standard —or a process that doesn't work. For example, many (but not all) diabetics inherit pancreas-pattern genes which, instead of generating a normal pancreas gland, generate an inadequate one.

Will all the children of a diabetic have diabetes?

No. Most likely none of them will.

Now wait a minute! If one parent got defective genes from his parents, won't they be passed along to the children?

They might. But there are forces working against it. First there's only a 50-50 chance that the defective partner in the gene pair will be passed on. Even if it is, there's a good chance that it will remain inactive. Defective genes are usually "recessive"—dominated by the other member of the pair.

The trouble arises when a child inherits defective genes from *both* parents. Or if he gets defective genes from one parent, and weak genes from the other parent that cannot mask the defective ones.

Does that mean some hereditary trait could be hidden in both parents but appear in their child?

Exactly. And the trait might not necessarily be a bad one either. Blue eyes for example. The blue-eye gene is recessive. That means that brown-eyed parents might carry blue-eye genes as partners to dominant brown-eye genes. But if each parent passed on a blue-eye gene, the child's eyes would be blue.

Don't genes ever mix? Wouldn't the children of a blue-eyed mother and a brown-eyed father have bluish-brown eyes?

Each gene usually has an all-or-nothing effect. But, many human characteristics are caused by more than one gene pair. Eye

[Continued on page 210]

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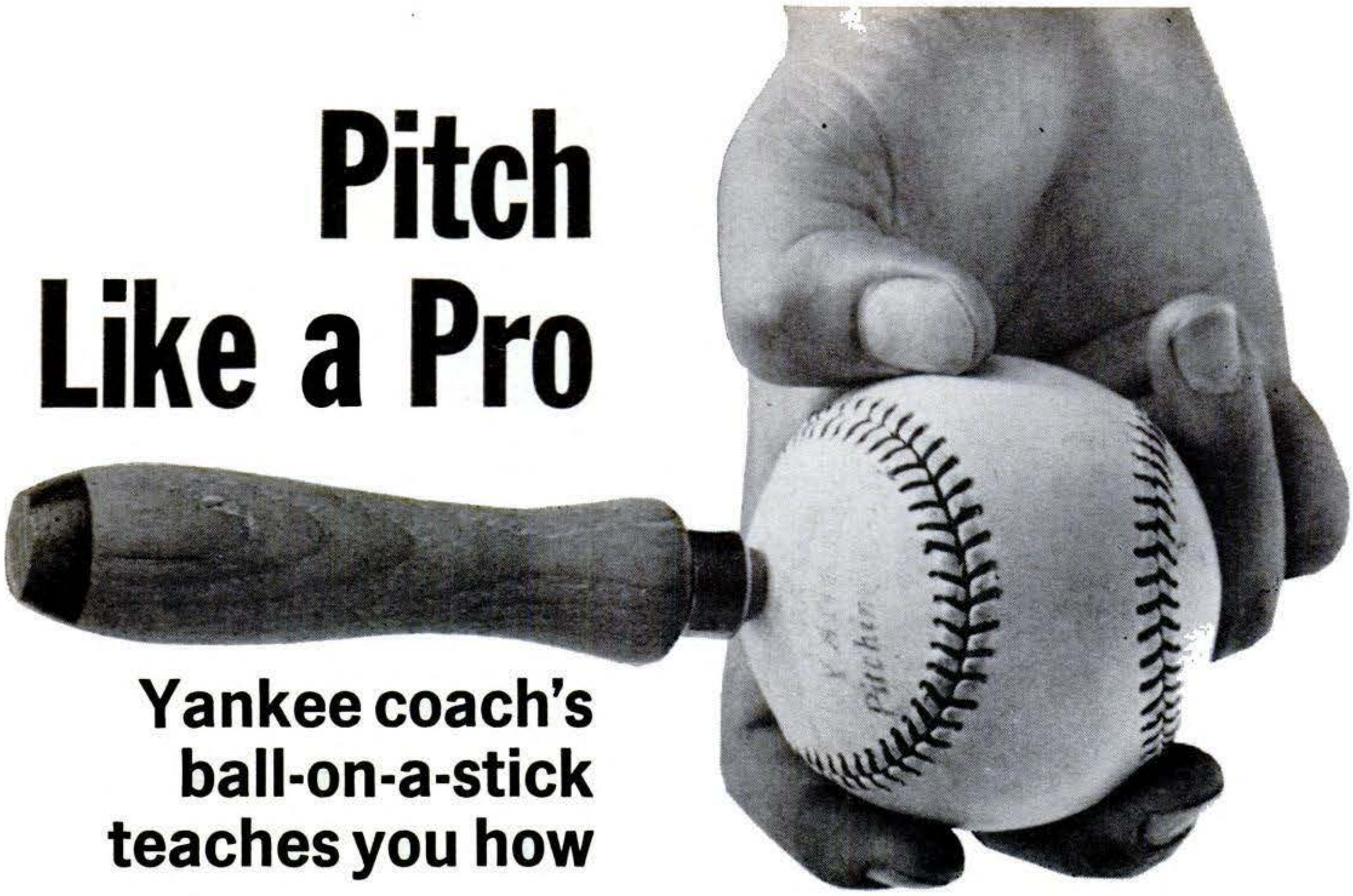
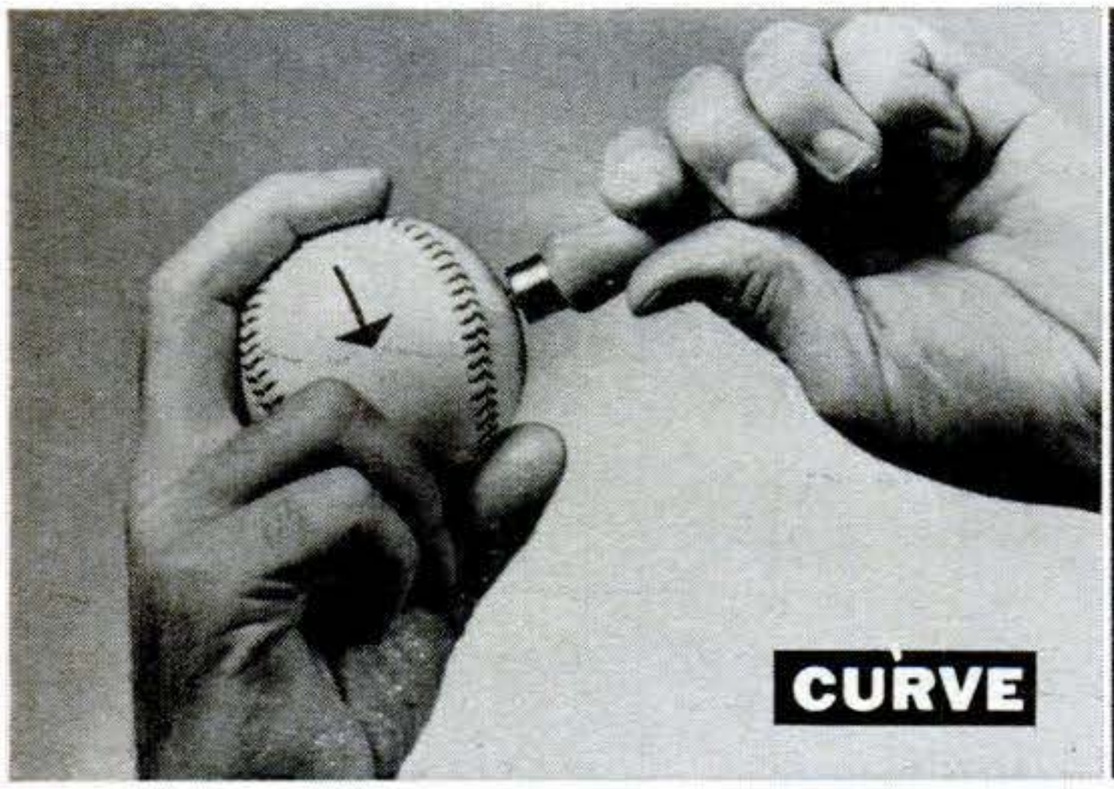
Pitch Like a Pro



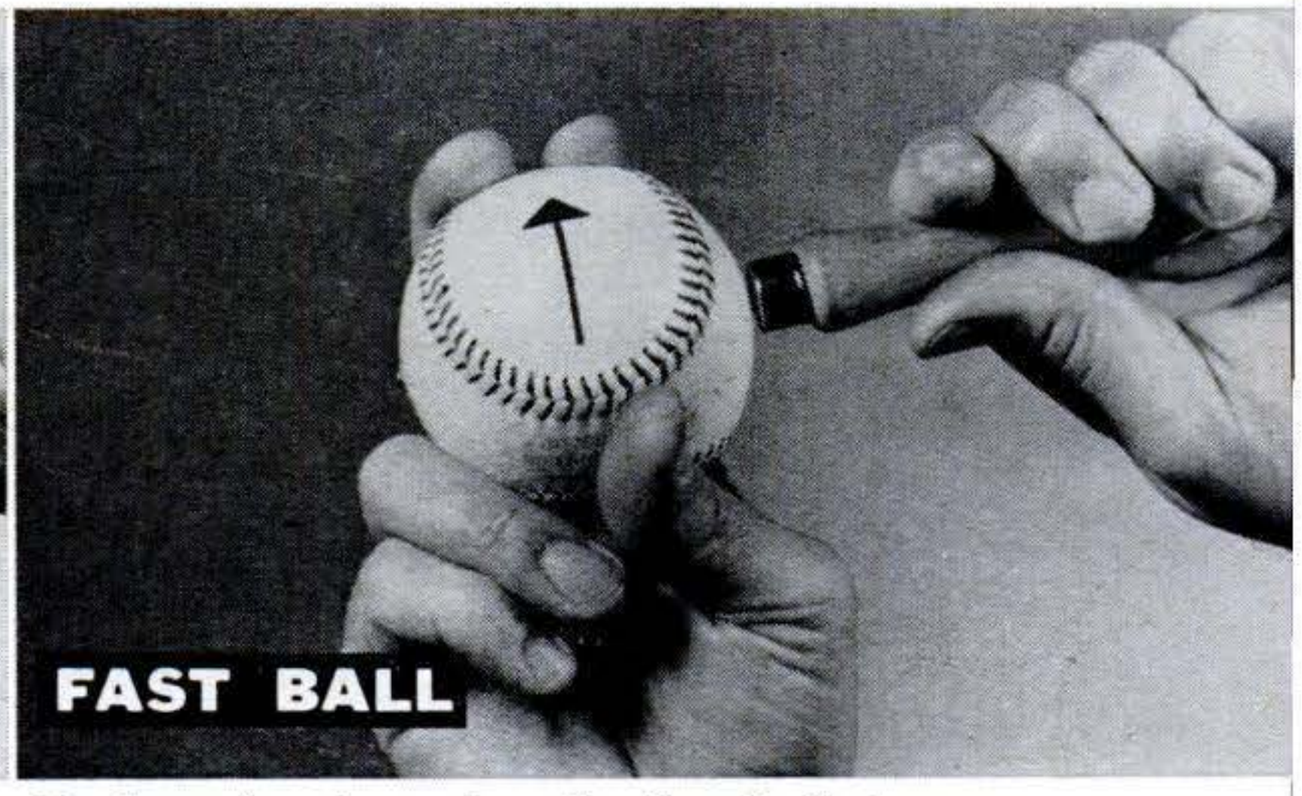
Yankee coach's ball-on-a-stick teaches you how

DROP in on the New York Yankees during practice and you're likely to see star pitchers walking around spinning a baseball on a handle. Invented by veteran hurler Johnny Sain, this ball-on-a-stick is no toy. Sain, now pitching coach for the Yankees, devised it to help train pitchers in the complex science of throwing balls that curve, sink, slide, and do other tricks.

The idea: By spinning the ball on the handle, you see and learn the proper pitching motions without actually throwing it. With practice, these motions then



Direction of spin and axis tilt are the two key factors in any pitch. To throw a curve, the spinner handle is tilted up slightly, tipping the ball's axis away from the pitcher. The ball is spun forward between fingers and thumb. The faster the spin, the sharper the curve breaks. All pitches here shown are as thrown from a three-quarter arm position, which most pitchers use. Axis tilt is steeper when the ball is side-armed and flatter when it's overhanded.



Backward spin makes the fast ball do strange tricks, giving it a hopping motion. When thrown overhand, the ball actually levels off and begins to rise. From either a three-quarter or side-arm position, it moves in on a right-handed batter, away from a lefty. Note that the ball is held with its axis tipped upward, as for a curve, but with the fingers directly behind it instead of off to the side. This gives you a lot of leverage; is why the fast ball has such speed.

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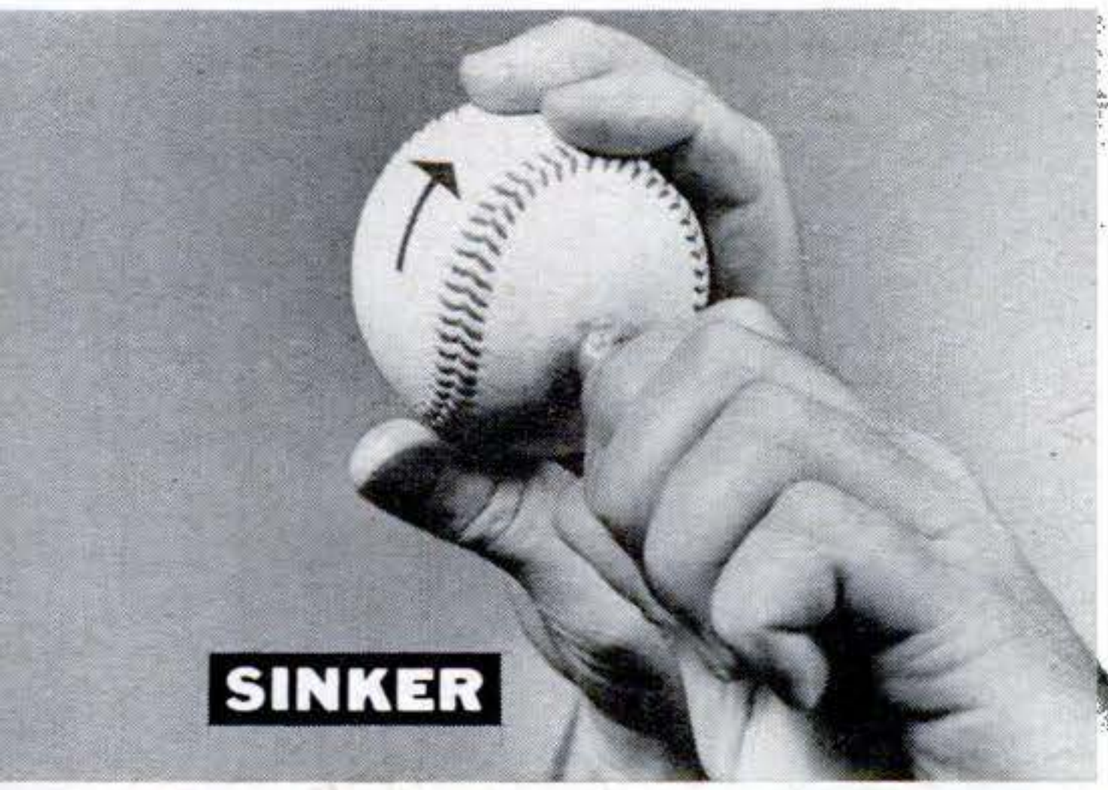
Veteran pitching-ace Johnny Sain demonstrates his baseball spinner to young Yankee star Jim Bouton (far left). By practicing correct spins, both pros and youngsters can improve their technique for throwing real pitches.

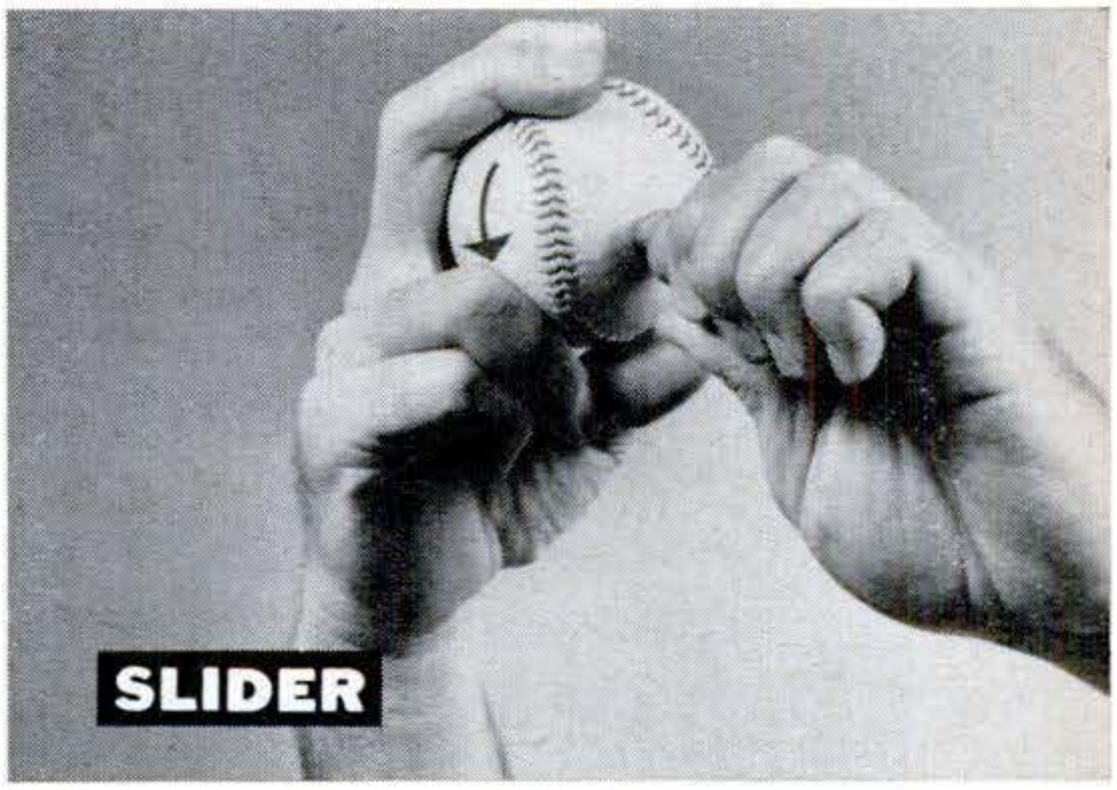
become automatic when you throw real pitches. Says Sain, "I've seen pitchers who didn't even realize a fast ball spins backward until they saw it turn on the handle."

In making his ball-on-a-stick, Sain uses a familiar shop dodge to get a straight hole through the ball. With an electric drill, he bores halfway through from one side, then lets the ball spin as the drill continues to run. This produces a dead spot on the other side exactly opposite the first hole. He then drills a second hole at this point to meet the first hole. A length of small metal tubing is pushed through the ball to make a bearing, and a long nail is driven through this and into an ordinary dime-store file handle.

In addition to training pros, the ball spinner is expected to aid school and college pitchers, Little League coaches, and fathers of aspiring young pitchers.



A sinker is thrown with the same backward spin as a fast ball, but with its axis pointing forward and downward instead of up. With the spin axis tilted downward in the same direction as the ball's flight, the ball tends to break downward or sink. The sharp twist of the wrist needed for this motion sacrifices some forward speed of the ball. This is why the sinker is not so fast as the fast ball although it's thrown in a similar way. Caution: Watch out for arm strain.



Slider combines motions of a curve and a sinker. Ball's axis is tilted down and forward like a sinker's, but the spin is forward like a curve's. Note that spin is applied by pulling the fingers down and flipping the thumb up, also like a curve. The difference is that the axis of spin—representing the direction in which pitch should break—is the opposite of a curve's. Sain's advice: Practice all pitches at half speed until you master the mechanics of how they're thrown.

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The Mighty F-1

Most powerful rocket engine is now being test-fired for our leap to the moon.

By Sandy Spillman

TO GET our astronauts to the moon, the first thing we have to do is lift 3,000 tons off the deck. That's the total weight of the Saturn V booster together with the Apollo spacecraft, three-man crew, and propellants – a hunk of hardware 387 feet high, taller than the Statue of Liberty and its pedestal.

That 3,000 tons is the equal of two dozen fully loaded Boeing 707 jetliners. It will take a powerful engine to give that tonnage the necessary kick in the pants. I first learned of that engine when I visited the National Aeronautics and Space Administration's Marshall Space Flight Center in Huntsville, Ala., where

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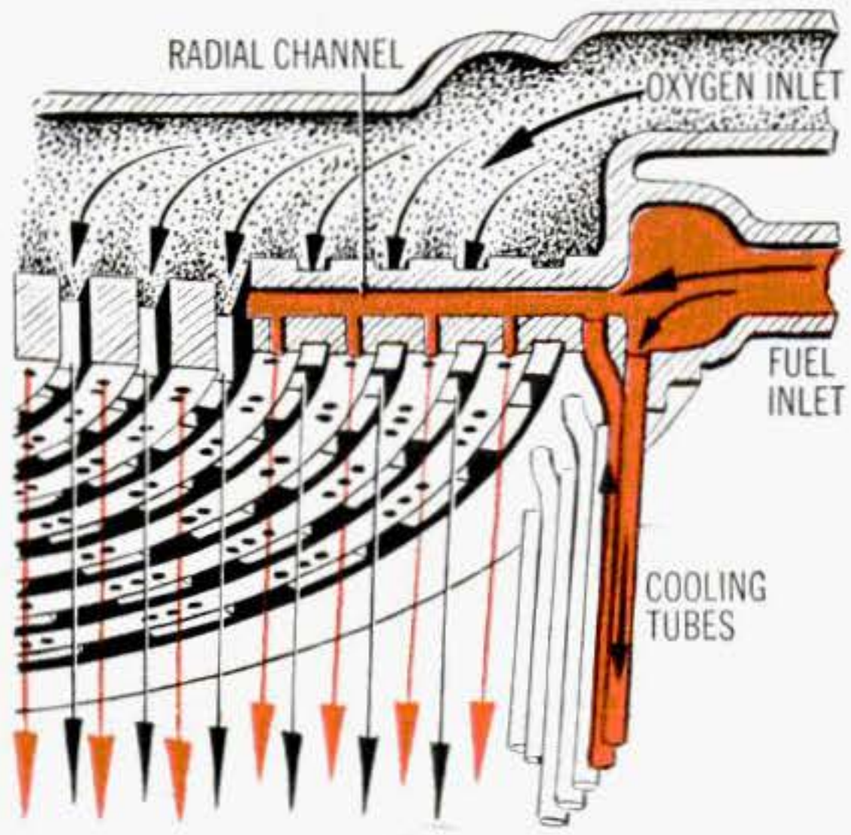
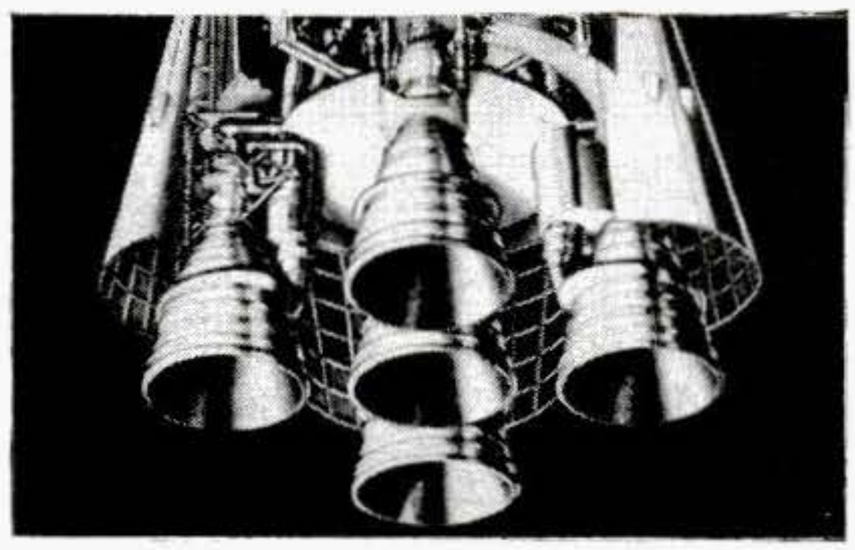
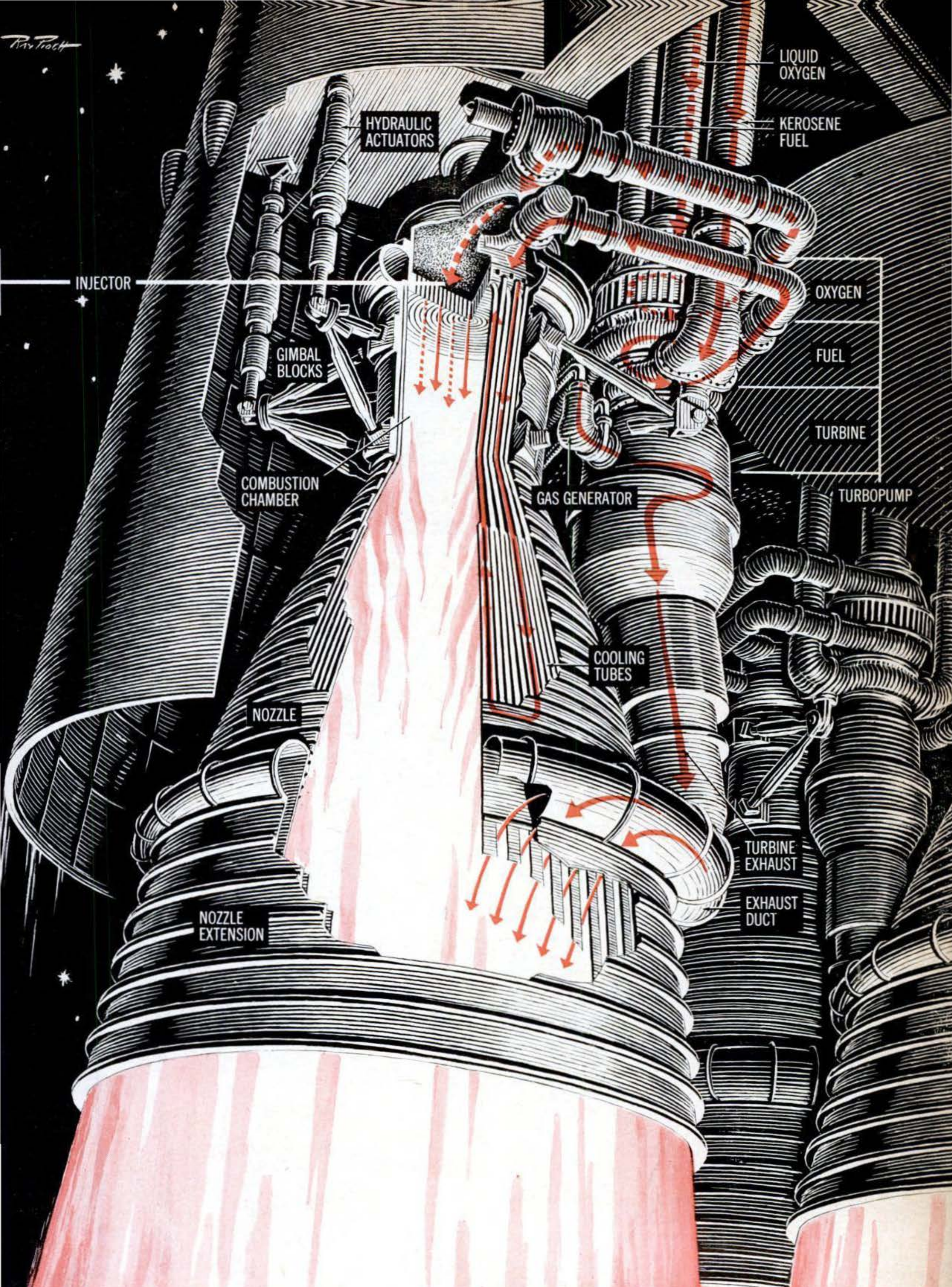


...and how it works

Fed by propellant tanks in booster, the massive turbopump forces three tons of kerosene fuel and liquid oxygen per second into F-1 engine. Oxygen goes directly from pump through injector into combustion chamber, where flame reaches 5,000 degrees F., but most of fuel is sent first through cooling tubes making up wall of chamber; some fuel goes straight into injector. Injector (detail above) sprays propellants through holes—2,600 for oxygen, 3,700 for fuel—into combustion chamber. Fuel from cooling tubes flows through 32 radial channels to orifices. Propellant pumps are driven by turbine powered by hot gases from kerosene-oxygen mix burned in elbow-shaped gas generator; 1,000-deg. turbine exhaust is fed around nozzle to act as coolant for hollow-walled nozzle extension before passing through slots into engine exhaust. Hydraulic actuators, using high-pressure fuel as working fluid, gimbal engine to steer the booster. Sketch below shows how five F-1 engines will be mounted in the base of the Saturn V.





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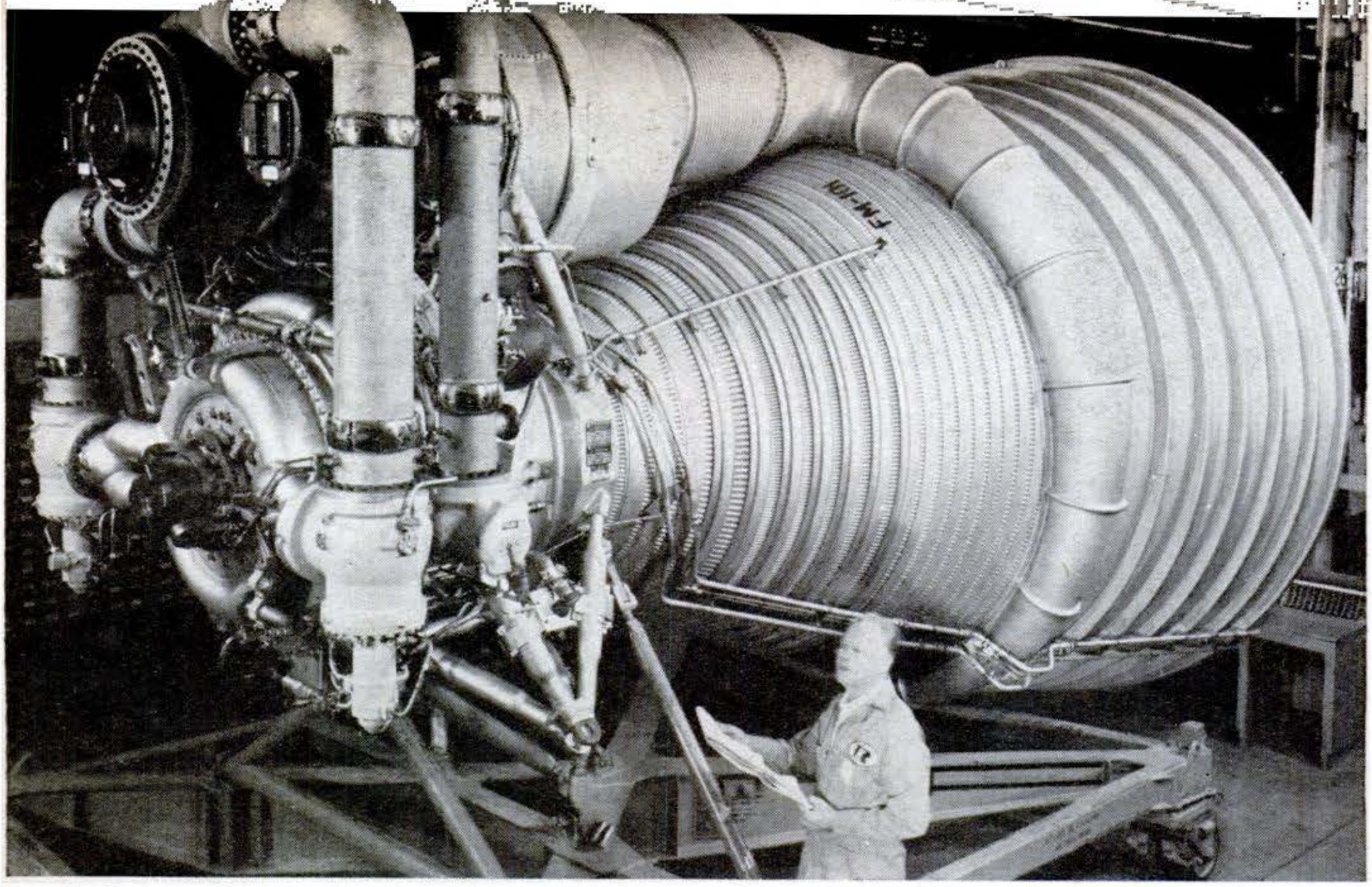


Ready for test-firing, F-1 engine is inspected at Rocketdyne plant. Cooling tubes that line combustion chamber are visible between strengthening bands around nozzle.

F-1 lights up the desert during a test-firing.

Dr. Wernher von Braun hangs his hat.

I was told that von Braun and his staff are counting on a cluster of five F-1 rocket engines as the motive power for Saturn V's first stage.

F-1 engines are scheduled to be delivered to NASA late this year. So far they have been test-fired by the builder, the Rocketdyne division of North American Aviation, in NASA's High-Thrust Test Area at Edwards AF Base, Calif. To observe a test firing, I went there.

The terrain is blanched, hot, and uninhabited—a perfect spot for testing large rocket engines. Giant test stands rise above the rugged earth. Gripped in Stand 1A was an F-1 engine. Eighteen feet high and thirteen feet in diameter, it poised like an open-mouthed monster about to spew fire.

The appearance was not an illusion.

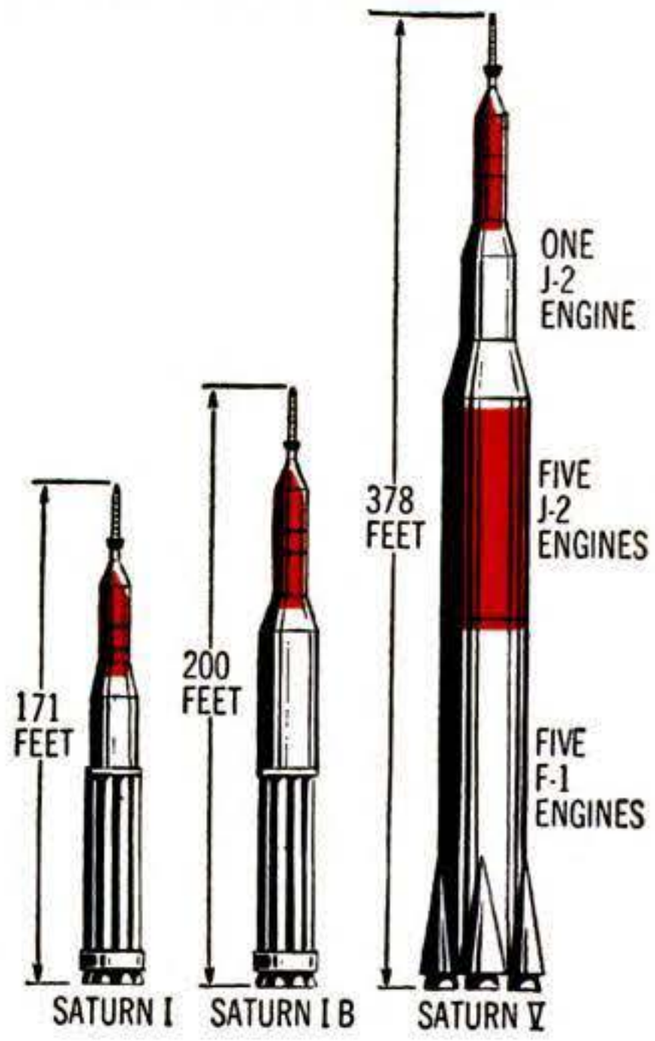
[*Continued on page 213*]

The big iron bird and how it grows

As the Saturn rocket booster evolves over the next few years, it is scheduled to go through a series of model changes, getting bigger all the time. Various stages and the engines that power them will be ready for flight test at different times. The three basic configurations are:

- The Saturn I, much like the Saturn rockets launched to date, using a cluster of eight Rocketdyne H-1 engines to power its first stage, with a second stage driven by six Pratt & Whitney RL-10 engines, burning liquid hydrogen and oxygen.
- The Saturn IB, using the same first stage, but with an improved second stage driven by a single hydrogen-burning Rocketdyne J-2 engine.
- Finally the Saturn V, with upper stages powered by J-2 engines and with the first stage driven by five F-1 engines.

The first two configurations—preliminary Saturn types—are to be used for flight tests of the Apollo spacecraft, including manned orbital flights lasting up to two weeks. The third is the configuration of the actual launch vehicle that is to be used for the Apollo moon flight.



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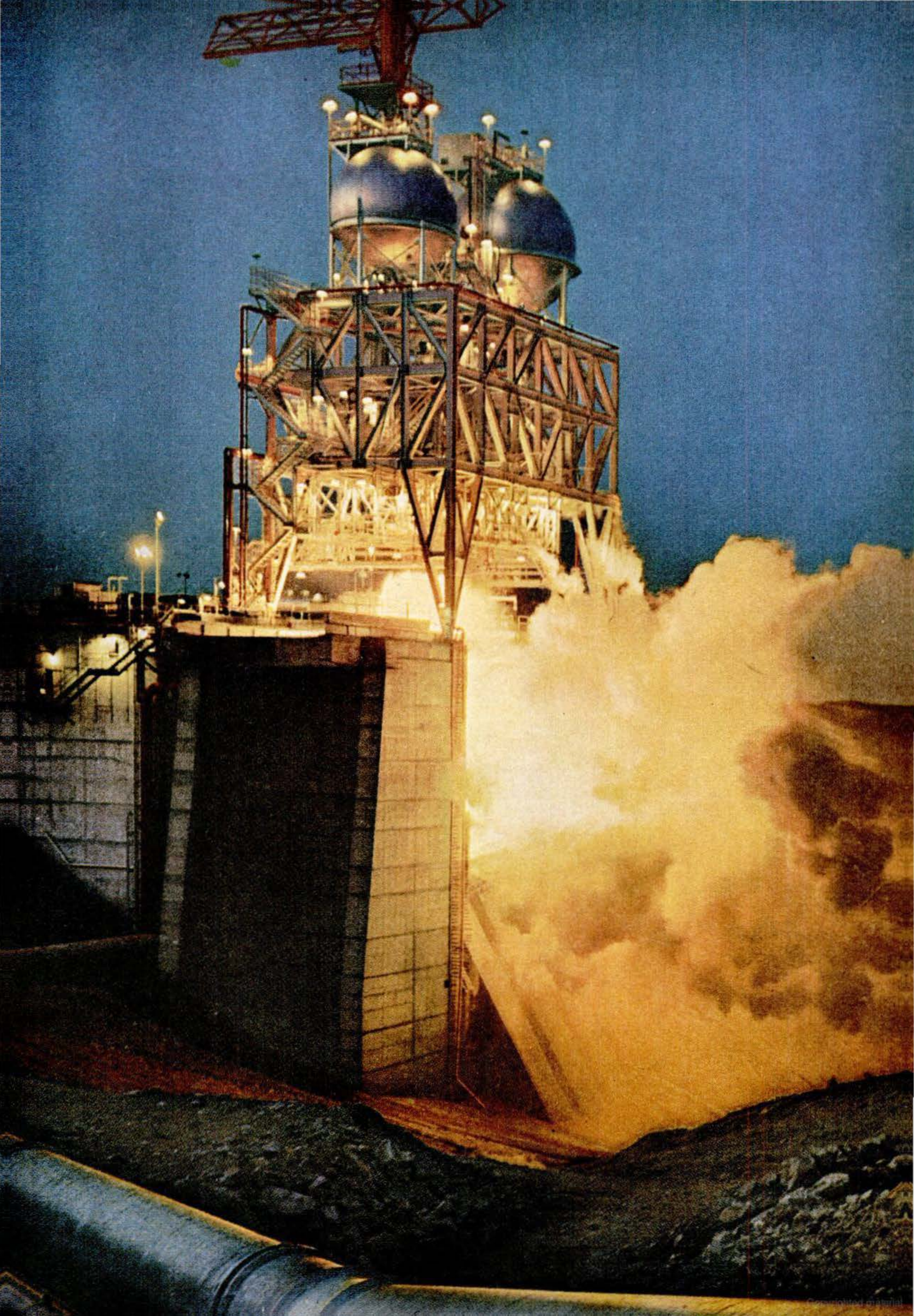

BIG NEWS!
'64 FORDS-BIG NEW BENEFITS FOR YOU

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NEW '64 FORD PICKUP

New durability in the toughest Ford pickup ever built... plus new riding comfort for you!

Sure-going toughness, easy-going comfort—you get them both in the new Ford pickup! Toughness because Fords are built with rugged, big-truck design in axles, frame and engine. Comfort because of Ford's new longer wheelbase and two-stage leaf springs that give you a smoother ride—loaded or light! And 26 pounds of cab insulation give a Ford the quietest ride yet!

NEW ECONOMY demonstrated in 100,000-mile run. In a five-month test by independent research engineers, five Ford pickups ran over gravel roads, highways, city streets for 100,000 miles per truck. Total costs for gas, oil, tires, preventive maintenance and repairs averaged only 3.2 cents per mile!

Easier ride with a new longer wheelbase. New 128-inch wheelbase is longer than that of many luxury cars. Smooth!

Easier loading with a new one-hand tailgate! Single handle in center operates latches at ends of tailgate on new bodies.

Greater durability with a double-wall box. Double steel walls in side panels of new boxes—sleeker outside, stronger inside.

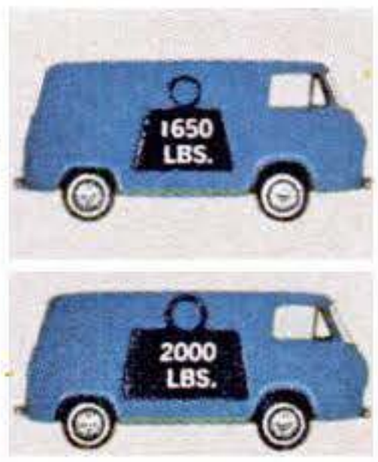
More comfort with a new Driverized Cab. Smart as a station wagon! Roomier new Custom Cab seats you on 5 inches of foam!

NEW '64 FORD Econoline Van

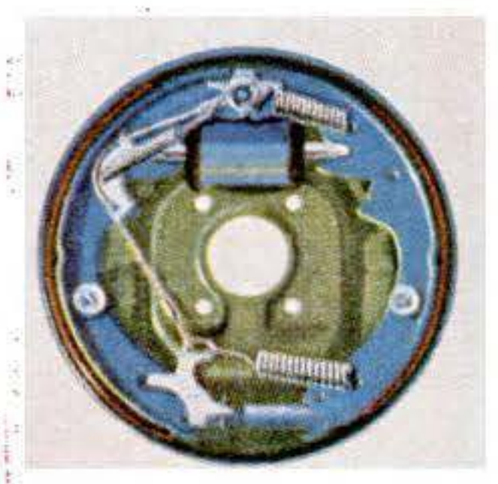
Outsells any truck in its class by 2 to 1... hauls more, costs less to run!

No wonder Econoline is America's favorite delivery truck. No other one truck offers so many advantages: more load-space—up to 56% more than old-style panels; long, low flat floor and up to eight big doors for easy load handling; low price and low operating costs. And Econoline's new features give you even more advantages in '64!

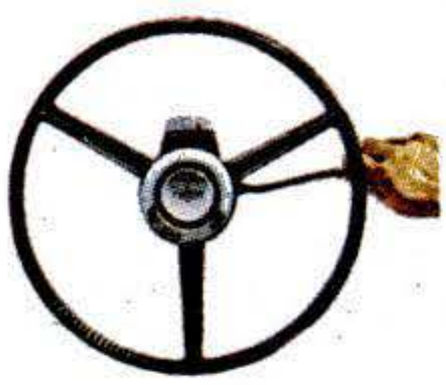
Test results: average running costs... 2.7 cents per mile! Independent 100,000-mile tests showed remarkable durability and economy for Econolines. Costs for gas, oil, tires, preventive maintenance and repairs averaged only 2.7 cents per mile! Check the certified report at your Ford Dealer's now!



More payload with 1-ton capacity. New optional heavy-duty model increases payload from 1,650 lbs. to a full 2,000 lbs.



Surer stopping with new self-adjusting brakes. Brakes automatically adjust themselves, increase safety... cut shop time.



Better performance with new transmissions. Optional automatic and 4-speed traffic transmissions for top performance!

More convenience with long, low flat floor. Load at low knee level—with no rear engine hump to get in your way!

PRODUCTS OF Ford MOTOR COMPANY

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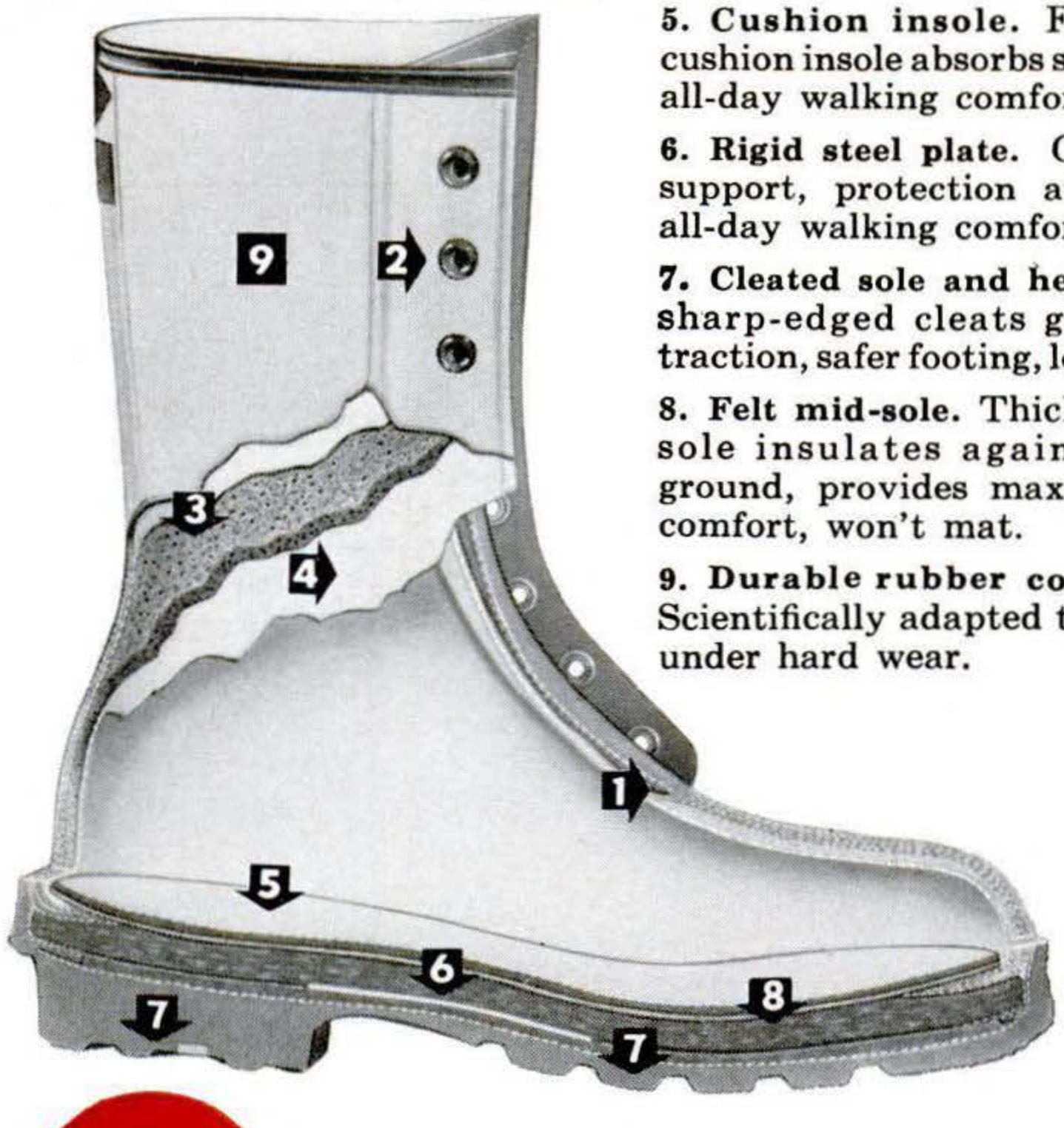
9 reasons why the boot that climbed Annapurna II is the best all-around boot for you

The Oneida! A boot that can take the world's toughest terrain! A light weight boot, yet warm and comfortable in sub-zero cold! This famous boot that climbed the Annapurna II can take anything you'll encounter hunting, fishing or on the job! Here are the reasons:

1. Self cleaning gusset. Prevents trapping of dirt and moisture. Opens wide for easy cleaning.

2. Rust-proof eyelets. Tough non-corrosive aluminum eyelets securely anchored for snug lacing.

3. Thermo-ply insulation. Shuts out cold, won't absorb moisture even if snagged. This famous sealed unicellular insulation wraps entire foot in protective warmth. Lets you hunt the coldest day in comfort.



4. Heavy net lining. Top quality net lining wears and wears, never loosens.

5. Cushion insole. Full-length cushion insole absorbs shock, gives all-day walking comfort.

6. Rigid steel plate. Gives extra support, protection at arch for all-day walking comfort.

7. Cleated sole and heel. Husky sharp-edged cleats give better traction, safer footing, longer wear.

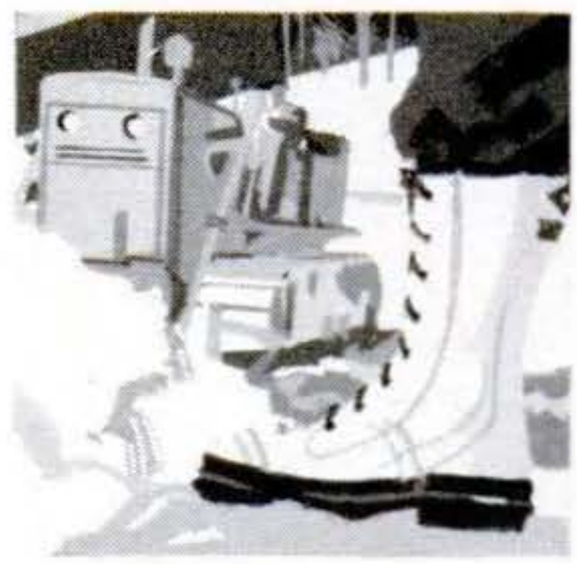
8. Felt mid-sole. Thick felt mid-sole insulates against frozen ground, provides maximum foot comfort, won't mat.

9. Durable rubber compounds. Scientifically adapted to stand up under hard wear.

Sure footing
for mountain climbers

All day walking comfort
for farmers

Better traction
for line-men



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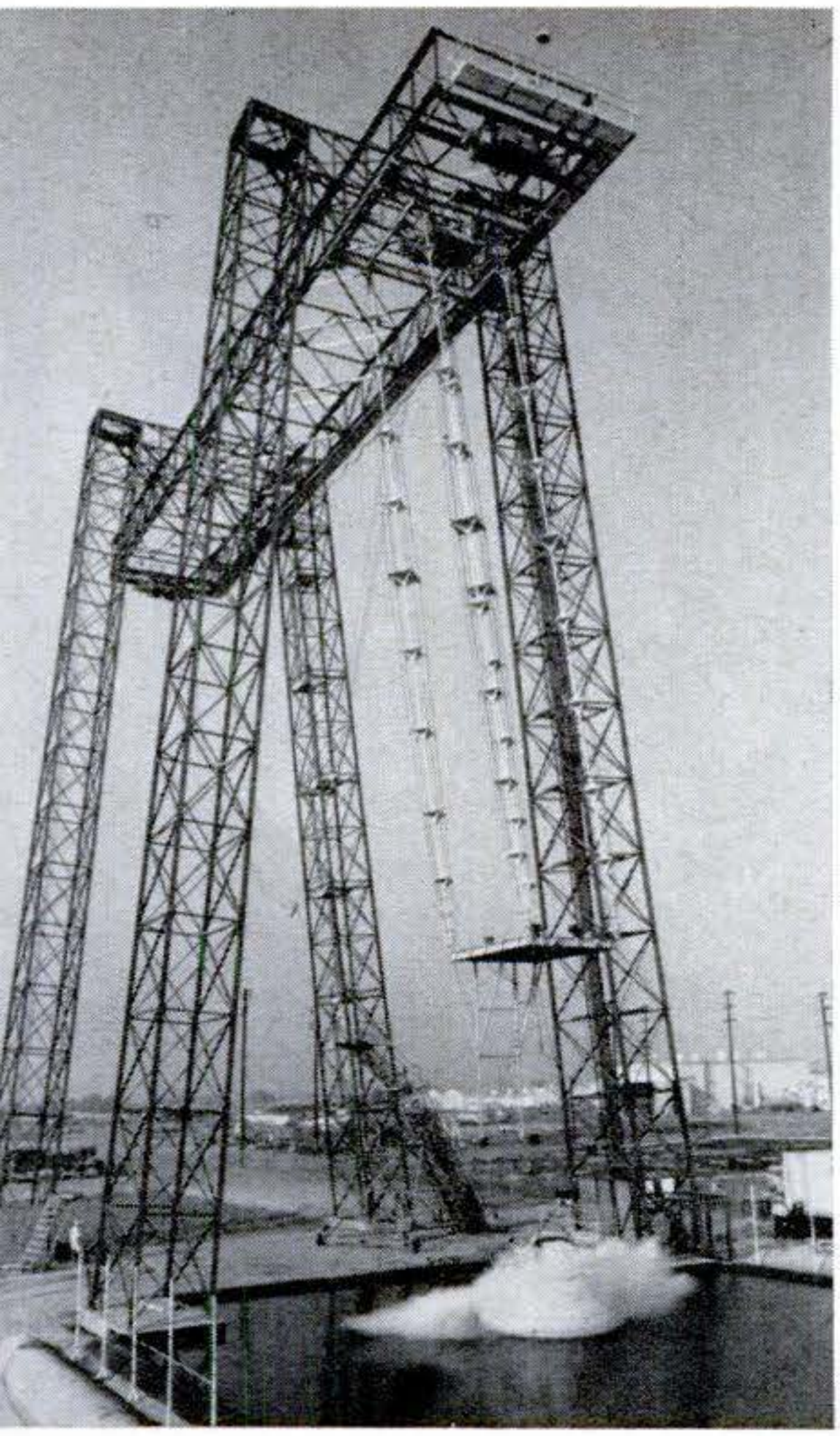
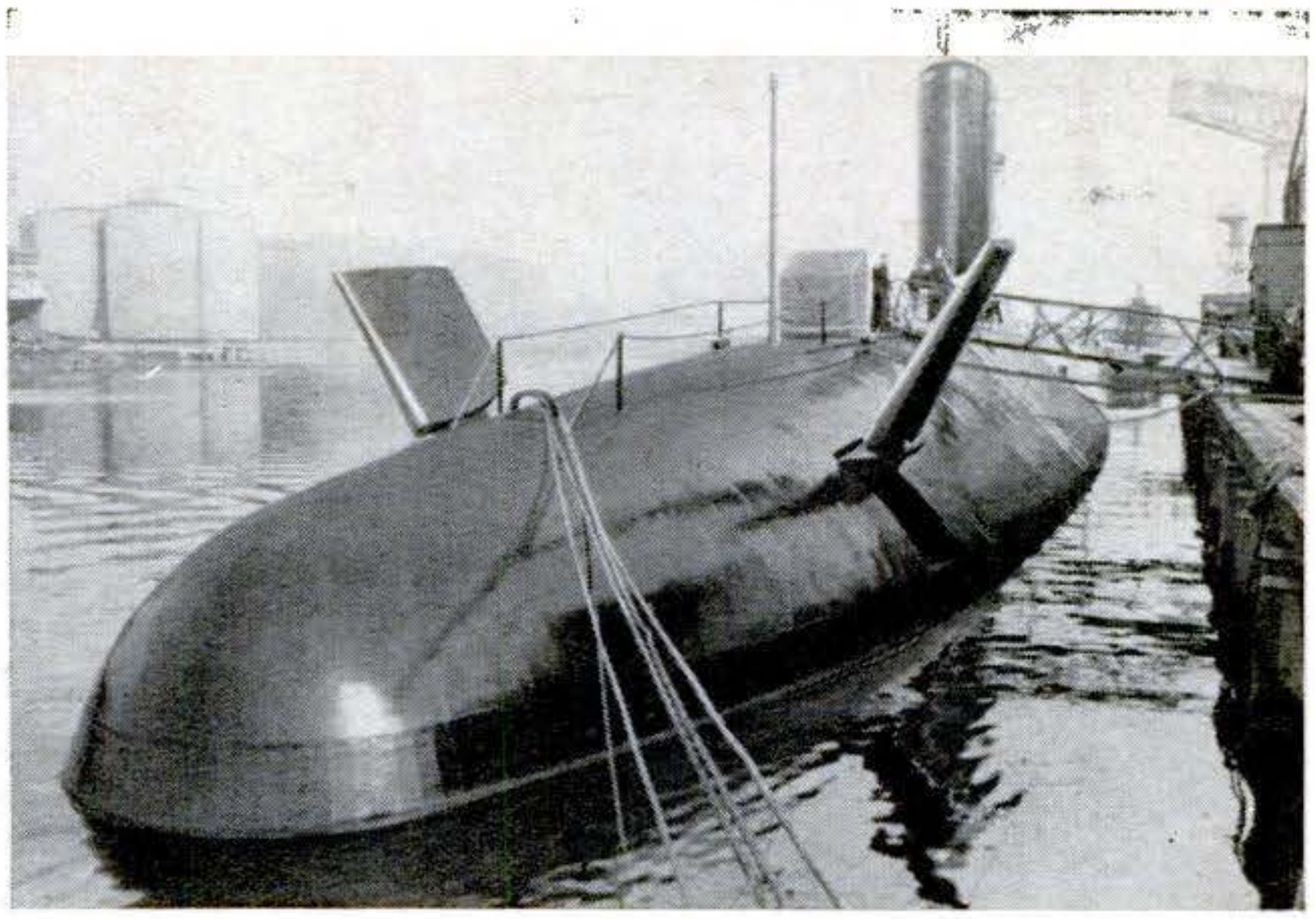


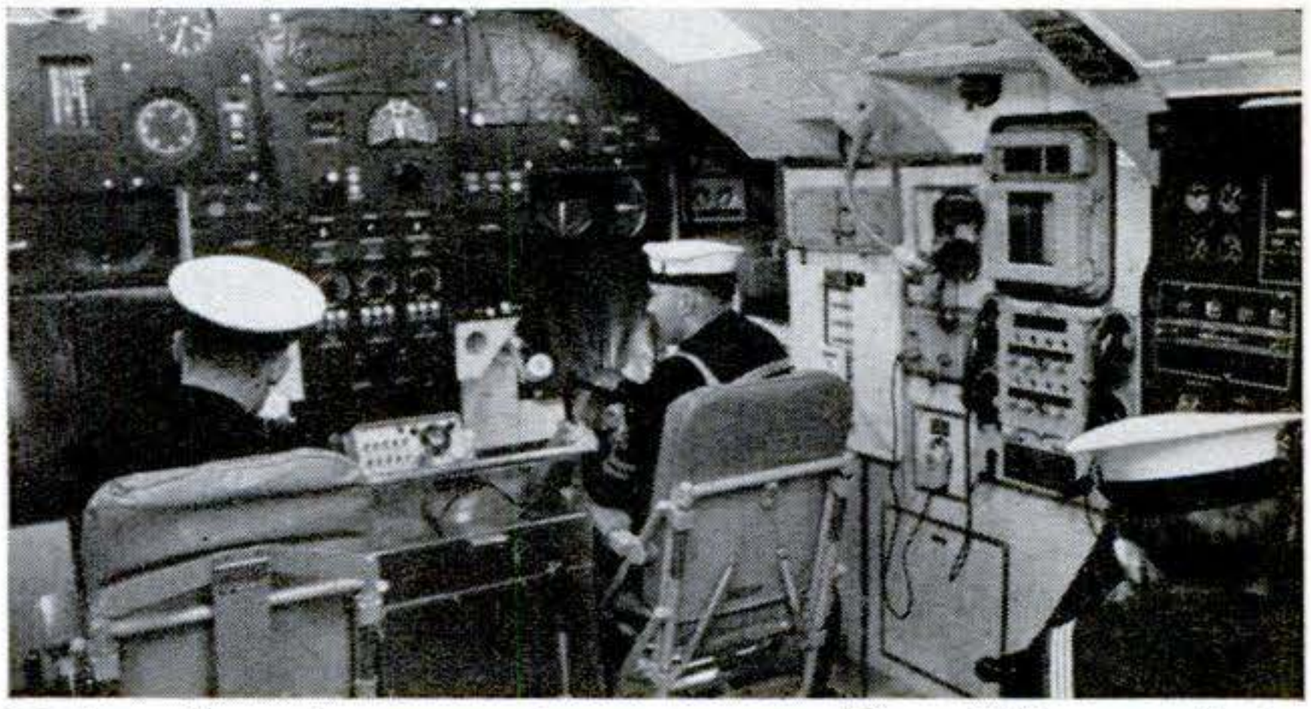
Giant pendulum swings spacecraft for tests

Earth landings of the Apollo capsule are simulated from this 143-foot tower. Suspended from a 90-foot pendulum running along a track, the capsule is dropped on land or water at controlled speeds to determine the effect of impact on equipment.

After preliminary tests in California, North American Aviation will re-erect the tower at NASA's Houston center.



H.M.S. Dreadnought lies in dock like a surfaced whale.



Main submarine control room resembles airliner cockpit.

Atomic age for British navy

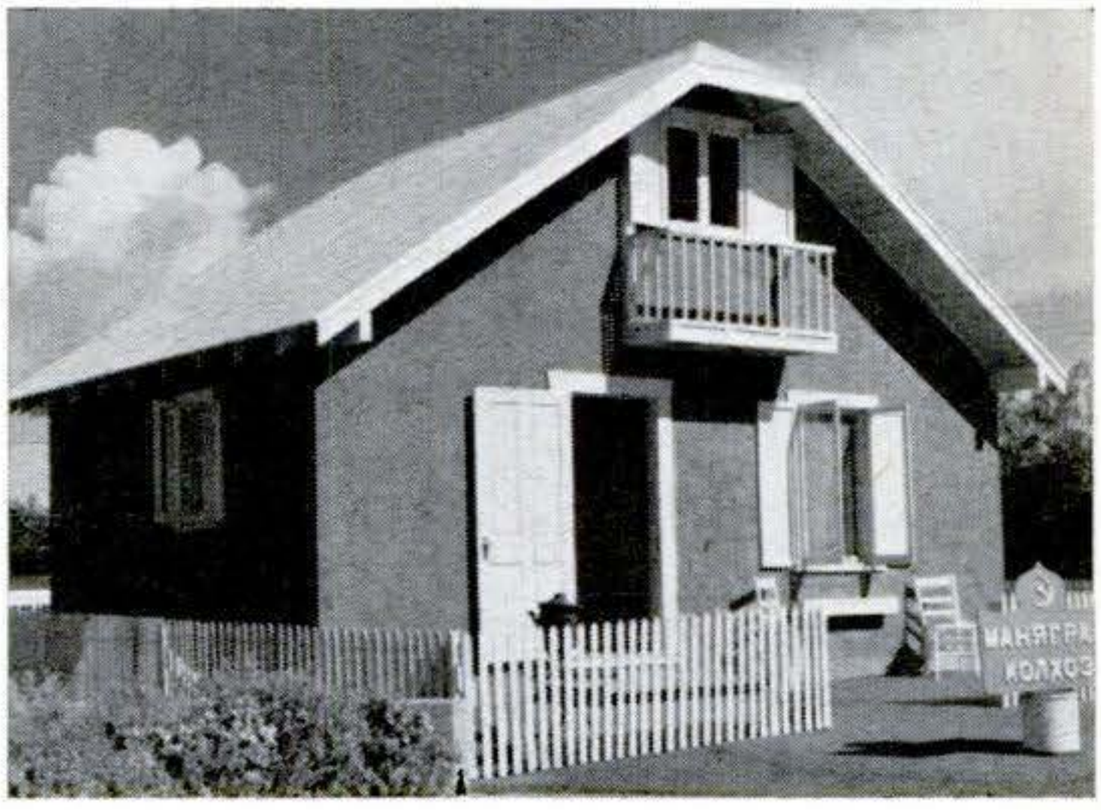
Britain's first nuclear submarine is designed to hunt and destroy enemy subs. The hunter-killer Dreadnought, third warship to bear the name in this century, is 300 feet long, displaces 4,000 tons submerged, and has an underwater speed of 30 knots.

The vessel has a reactor bought in the U. S., but a reactor for a second submarine is being built in Scotland. Instead of Polaris missiles, the Dreadnought carries a variety of secret torpedoes.

Typical Russian house built in U. S.

A Phoenix builder put up this 16-by-24-foot stucco house from plans in a Soviet magazine. There's a combined living room-bedroom, kitchen, and toilet (no bath) on the first floor. The kitchen sink has a cold-water tap only, and the kitchen stove supplies all heat. The house is intended for four adults, seven children.

In Russia, it sells for 21,000 rubles ($22,000, official rate of exchange; $8,400, free-market rate). John F. Long, the builder, says he could sell it for $2,500 —and make a reasonable profit.



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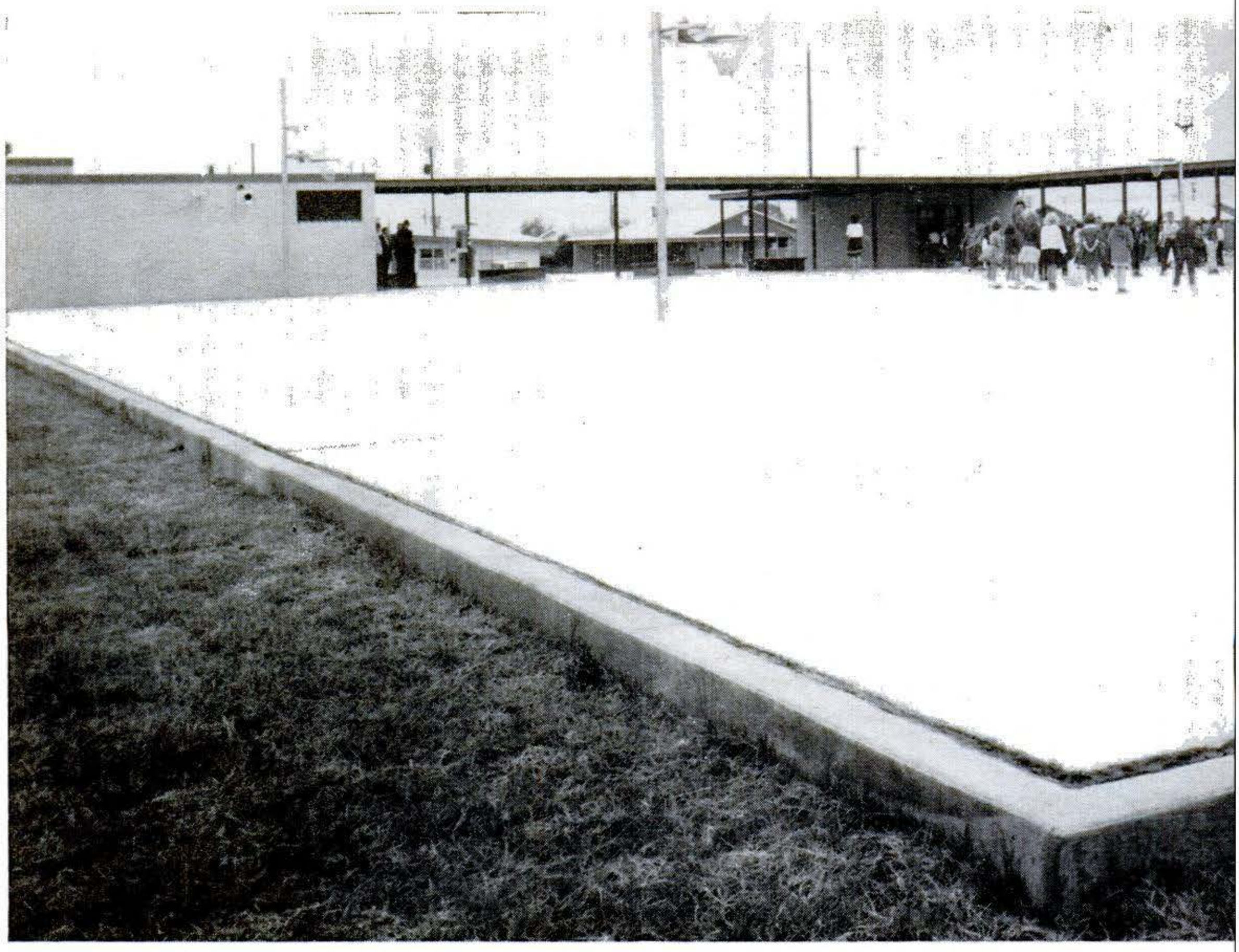

Underground school is fallout shelter

At the new Abo elementary school in Artesia, N. Mex., the children go up to the roof to play—and underground to study. The country's first underground school, it is also its largest fallout shelter. It accommodates 540 children through sixth grade, can house 2,160 adults and children for two weeks as an emergency shelter.

Reason for the bombproof school: It's 35 miles from Roswell, a SAC base and a prime target for nuclear attack, and within 200 miles of dozens of air bases and missile-

Supersonic jet fighter takes on back seat

The Air Force's 1,400-m.p.h. F-105D now has a two-seat twin with the same fire power, capable of the same missions.

Republic had only to lengthen the Mach-2 fighter 31 inches and increase tail-fin height to add a rear seat. The new F-105F is expected to double pilot flight time, eliminate the need for noncombatant jet trainers and chase planes.

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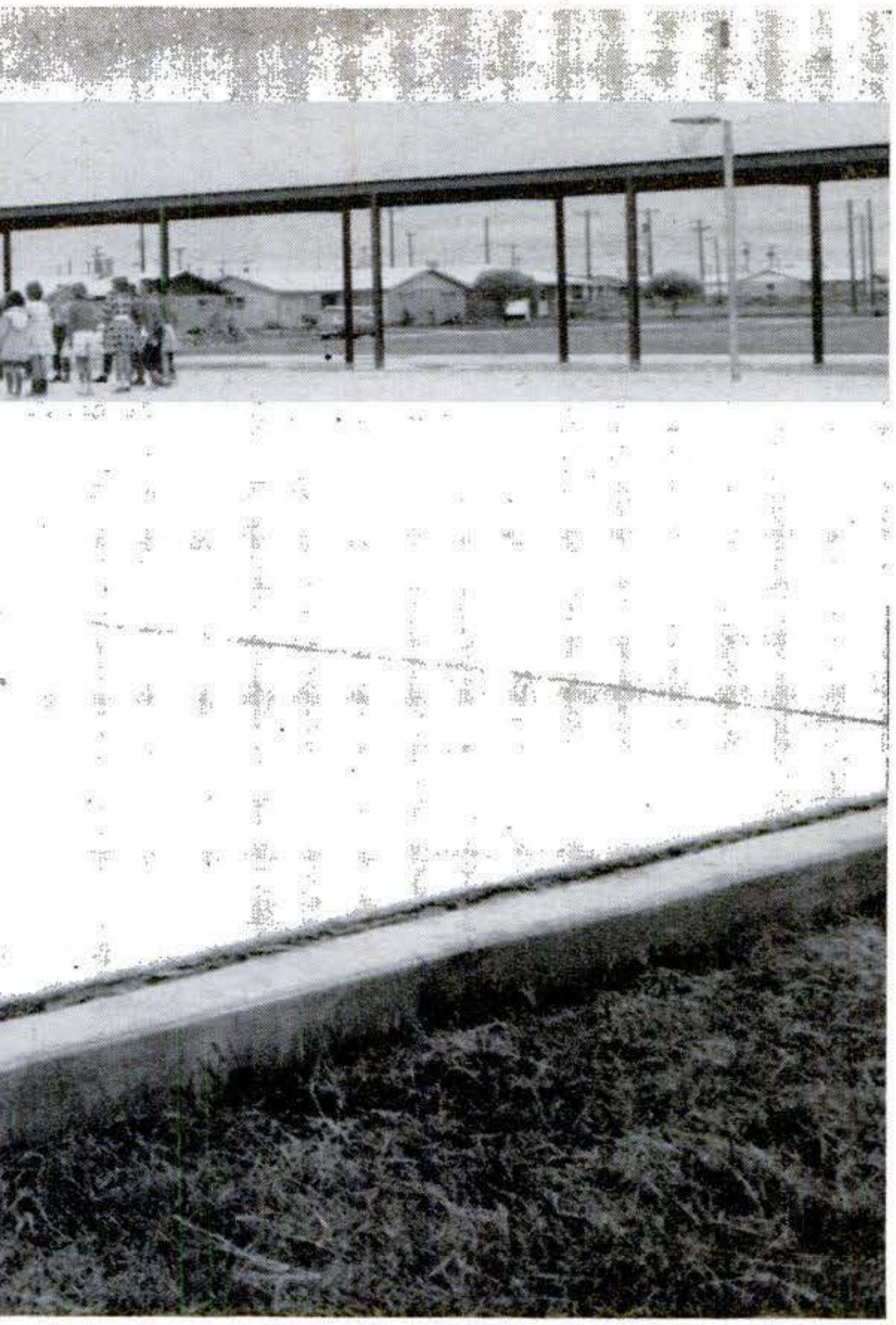
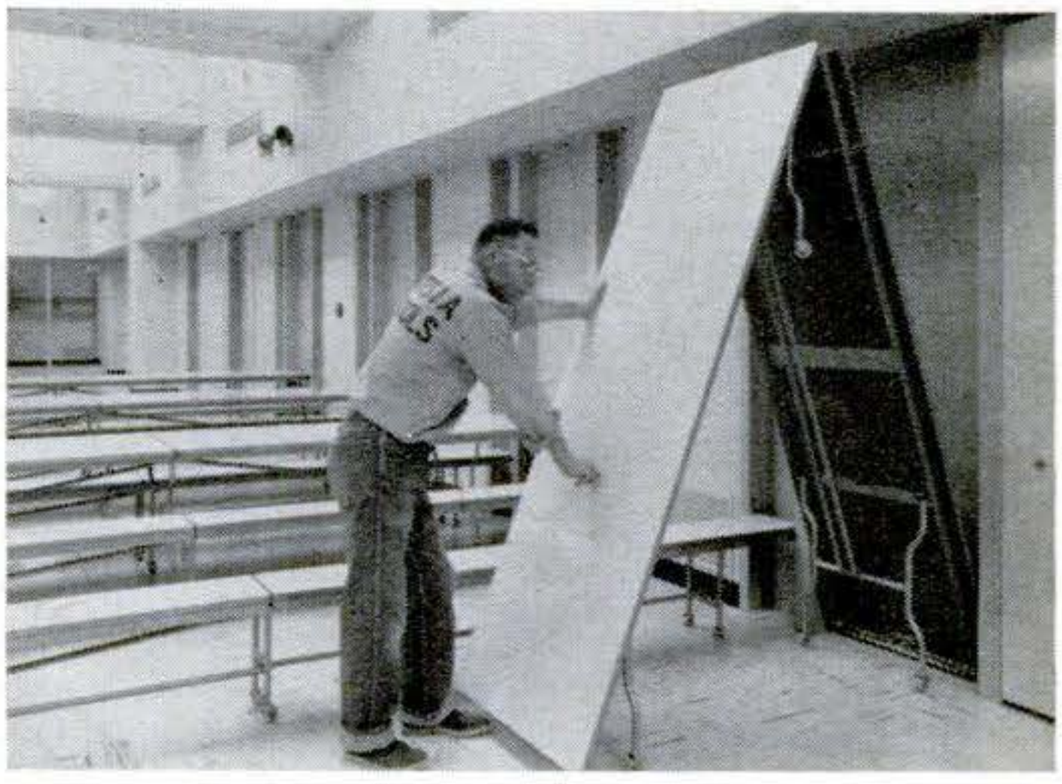


Concrete slab, 144 by 200 feet, and 21 inches thick, is both play yard and ground-level roof. Entrance is through kiosks at three corners.

Windowless classrooms are air conditioned, lighted in every corner, and distraction free. Diagonal seats provide view of two walls.



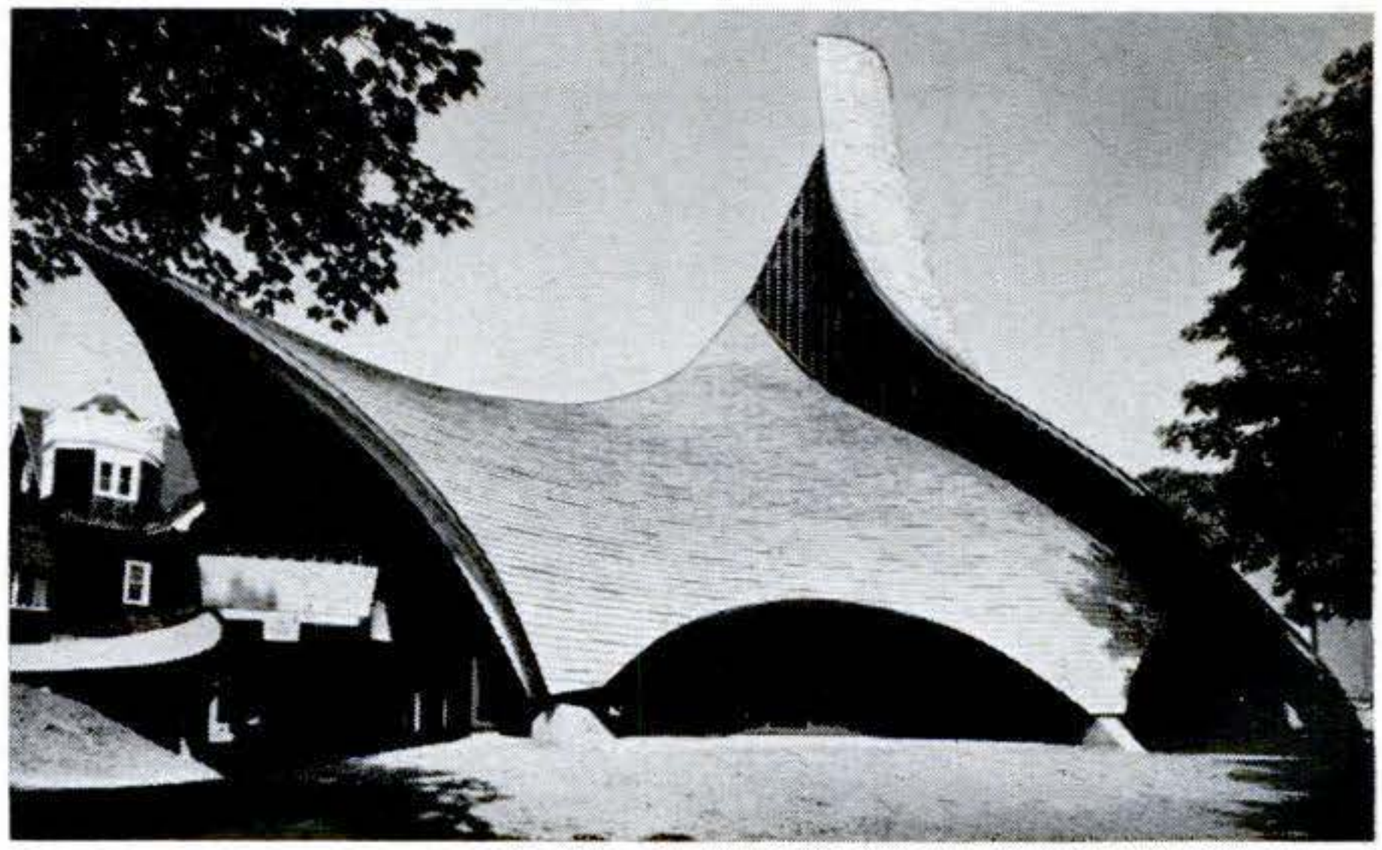
Tables, benches, and 12-by-20-foot stage fold into wall, converting classrooms into meeting or lunch rooms, or even sleeping quarters.

launching sites. It's built to withstand blast and fallout from a 20-megaton bomb.

The dugout schoolhouse has air conditioning and emergency lighting. Minneapolis-Honeywell installed a system of automatic controls for both. Sensors constantly check outside temperature, regulate complex equipment to keep interiors at 74 degrees. Other devices switch on batteries if power fails, lighting corridors and essential areas, and starting a 300-hp. diesel engine that drives a 150-kw. generator.

Billowing roof for new Connecticut church

The free-flowing design and soaring roof of red-cedar shingles attract visitors to the new United Church in Rowayton, Conn. Pews seating 250 are arranged in a semicircle; the altar is a slab of redwood on a boulder excavated on the site. Architect Joseph Salerno, of Westport, placed a stained-glass window in the rear peak to catch sunlight.



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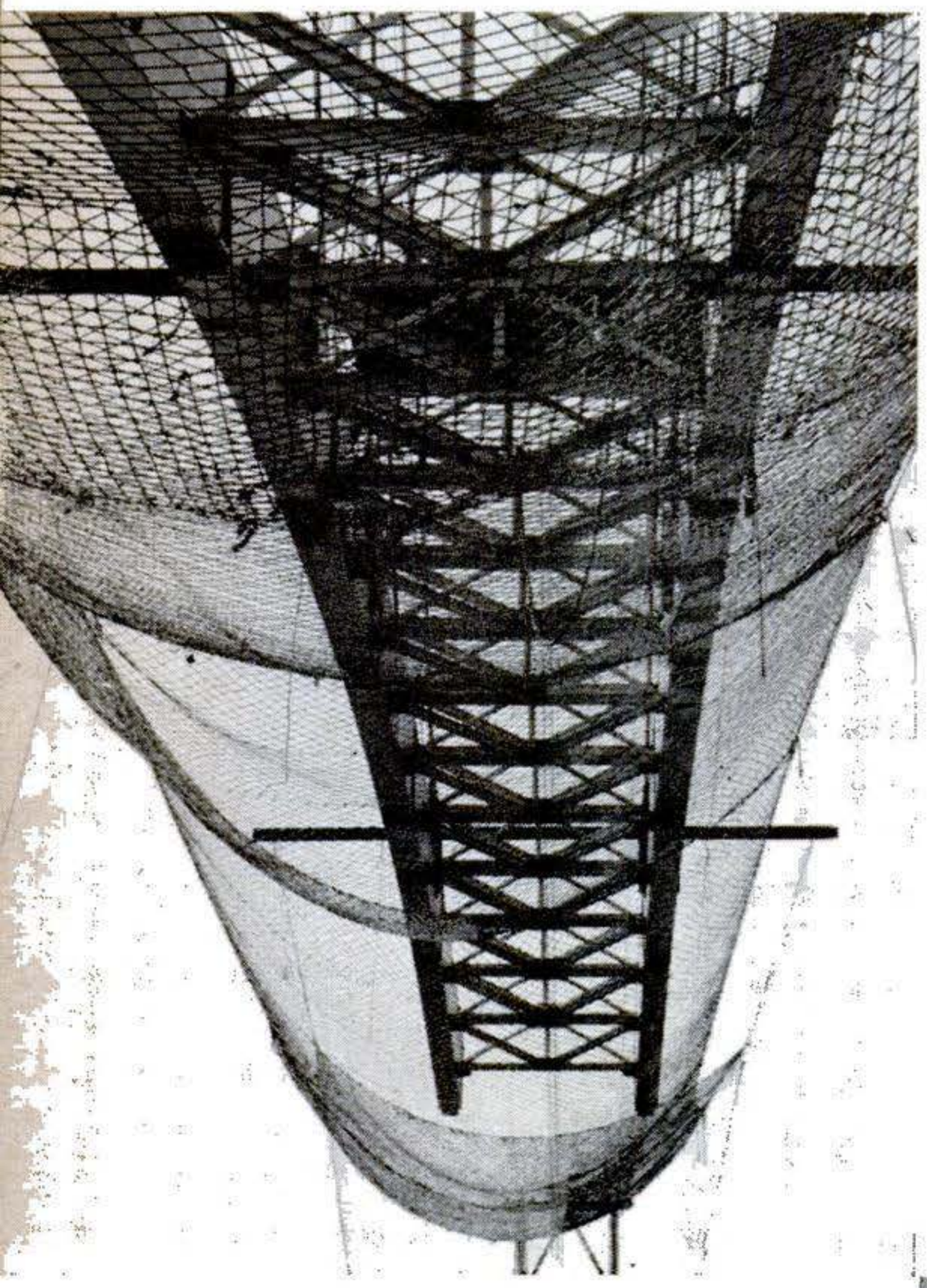
Building a Mighty Arch Bridge

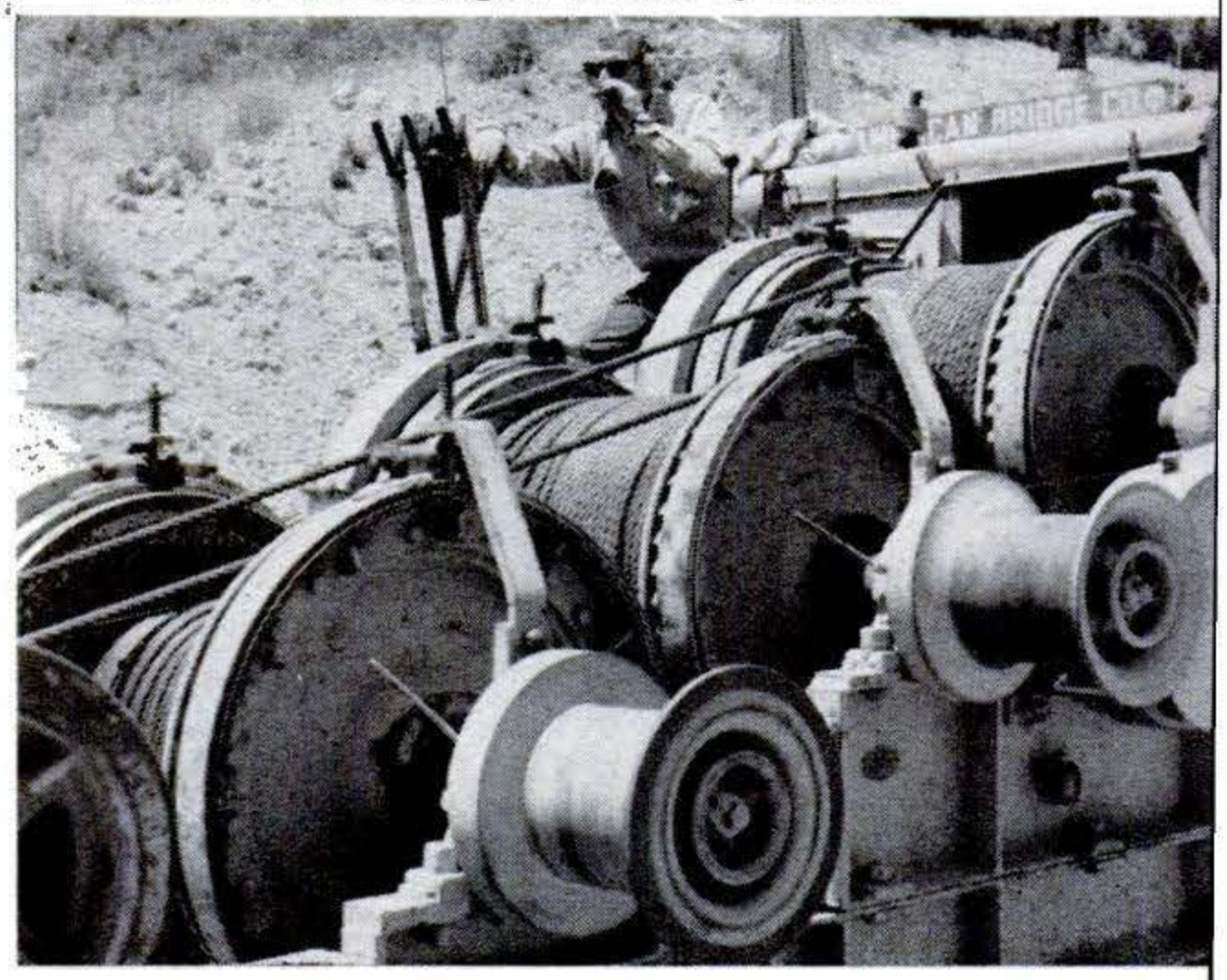


WHEN a projected highway meets an impassable canyon, it's a dramatic test of the bridge-builders' skill. Here's how they met the challenge near Santa Barbara, Calif., with the 1,211-foot Cold Spring Canyon Bridge, due to be completed this fall on California State Route 80 through Los Padres National Forest.

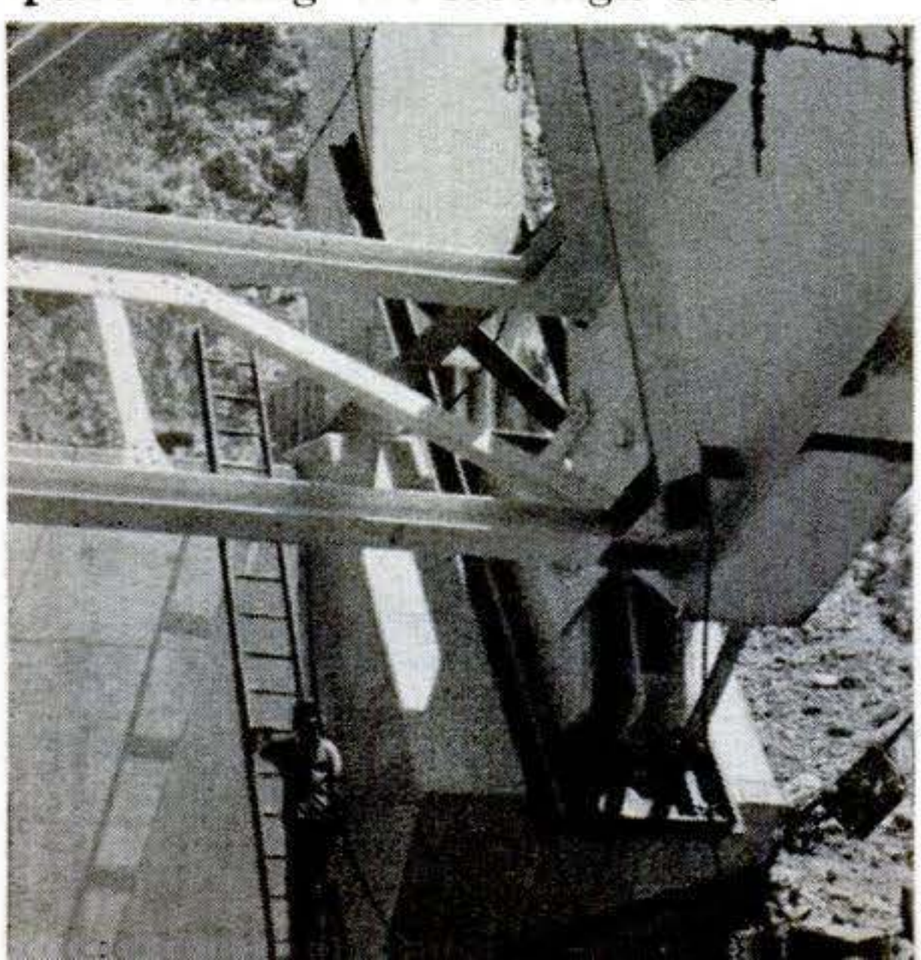
A graceful 700-foot arch of steel soars from wall to wall of the canyon, to form the main span. Building "falsework" to support it, during construction, was ruled out by the canyon's depth. So two high towers, braced by 18-inch-thick cables, temporarily carried the rising half-arches' weight. When the two sections met at the center, the bridge became self-supporting. Then a two-lane roadway was put across the canyon on the new bridge's steel decking, above the arch.—*Ross R. Olney.*

Safety net of rope hangs beneath rising arch of the Cold Spring Canyon Bridge, lest a misstep send a construction worker plunging toward floor of canyon, 567 feet below.

Operator of winch juggles control levers to raise a section of one arch into place. Since his post is out of sight of start of the lift, he wears a headset, gets orders by radio.



House-size concrete block (lower photo) buried in canyon wall and resting on bedrock, braces one end of the main span's soaring 700-foot-high arch.



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Soaring arch of bridge rises to meet section being erected from opposite canyon wall. At this stage, its whole weight hangs from temporary tower at upper right. Later, tower came down, and roadway to it was extended over the completed arch.

PHOTOS BY CHAN BUSH

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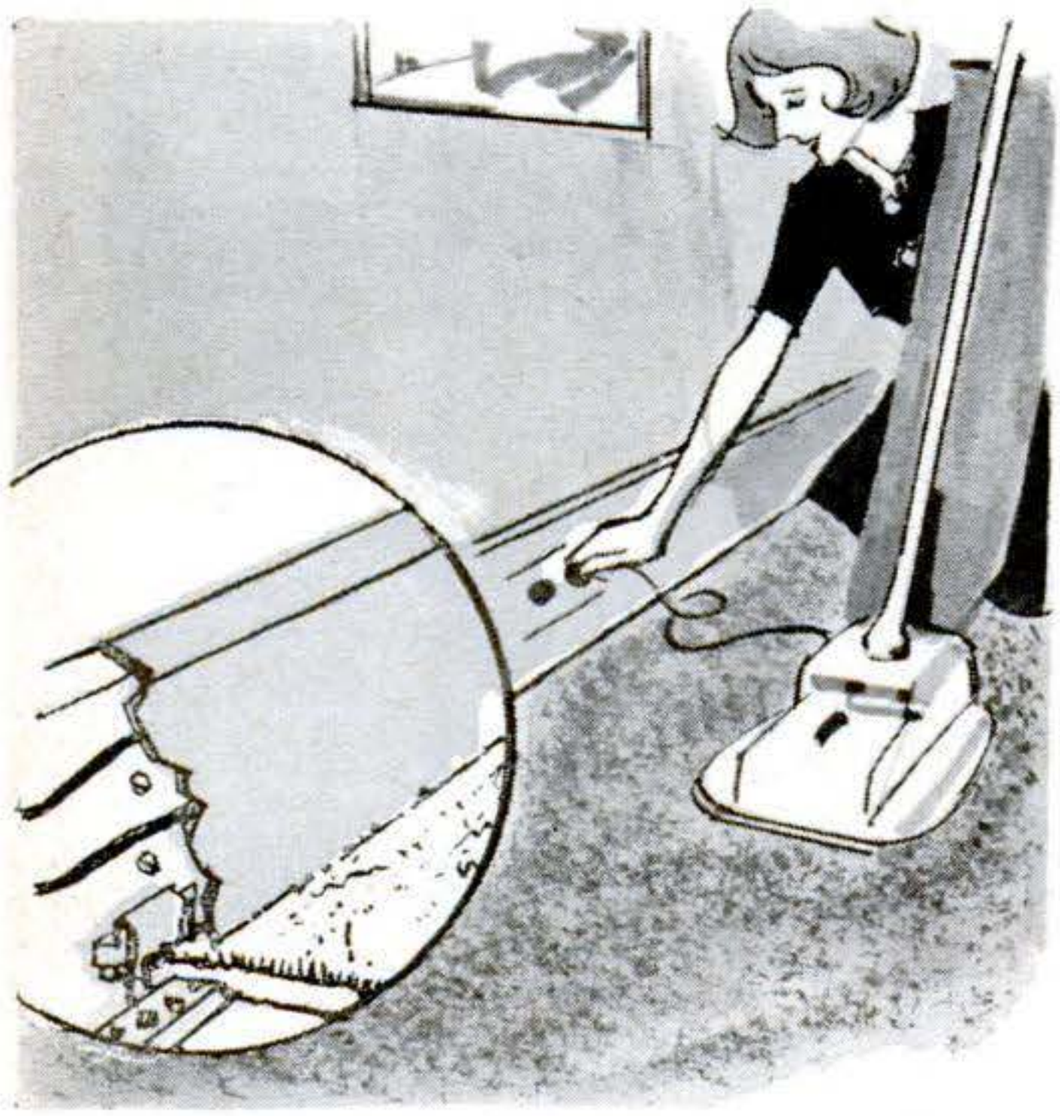
New ideas from the inventors

Foam floats sunken hull. Sunken ships might be raised quickly and economically, according to this recent patent, by pumping in foam. A diver would locate—or prepare—a closed compartment, insert a hose and nozzle. Pumps on a salvage ship would force in resin and catalyst. Combined at the nozzle, they'd set up to form a buoyant, closed-cell foam.



Baseboard anchors carpet. You could give your carpet (or floor tile) a trimmer look by anchoring the edges under this hollow baseboard. You'd anchor the carpet to a toothed strip screwed to the floor, then slip on the flanged plastic molding. Carpet edges would be covered, and wires would be concealed within the baseboard.

Tree stand seats sportsman. A fold-up stand that could be spiked and strapped to a tree trunk might make life more comfortable for hunters, nature photographers, and other outdoorsmen. This one would collapse into a flat pack, and the tree-girdling belt would convert to shoulder straps for easy carrying.

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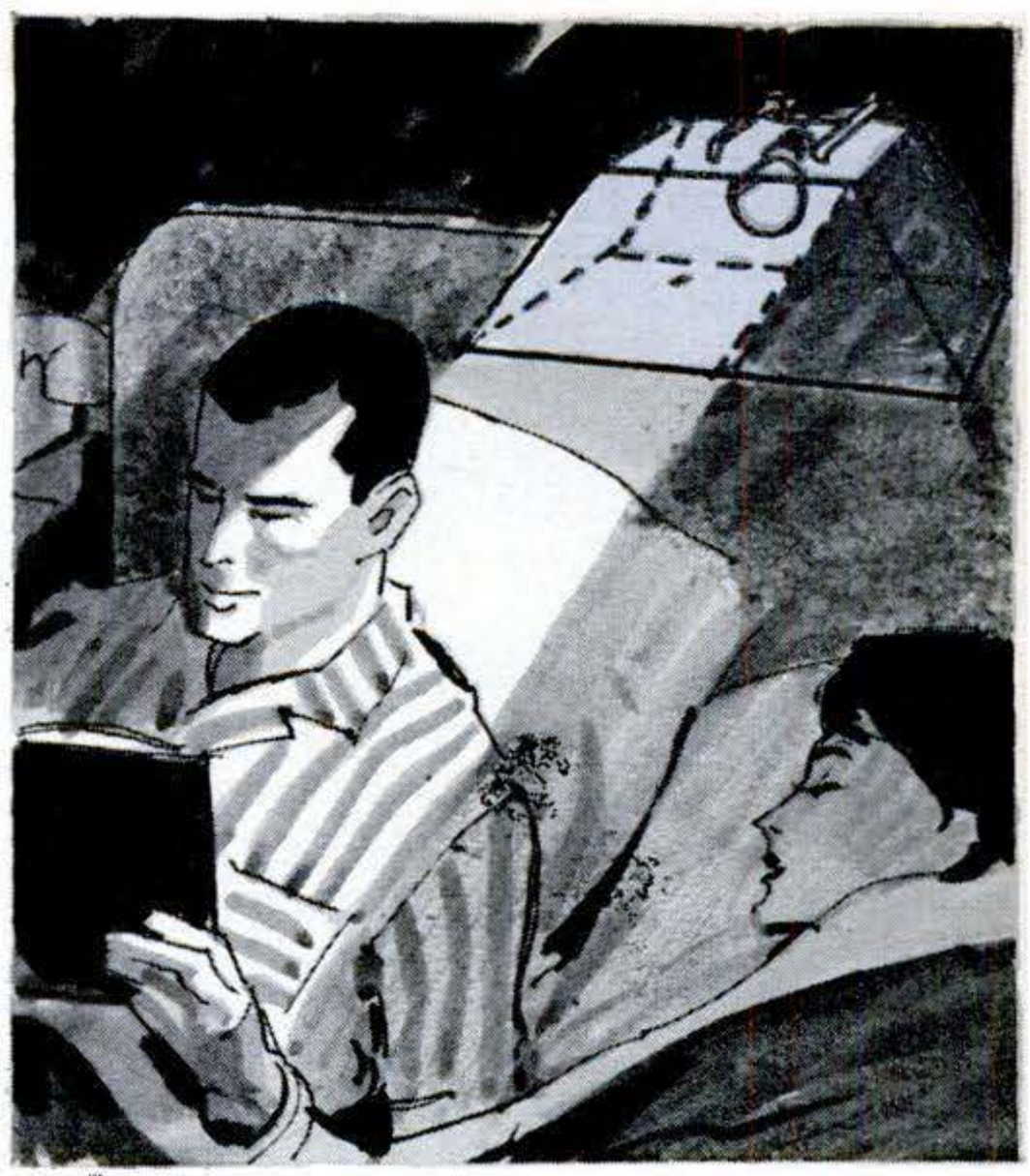
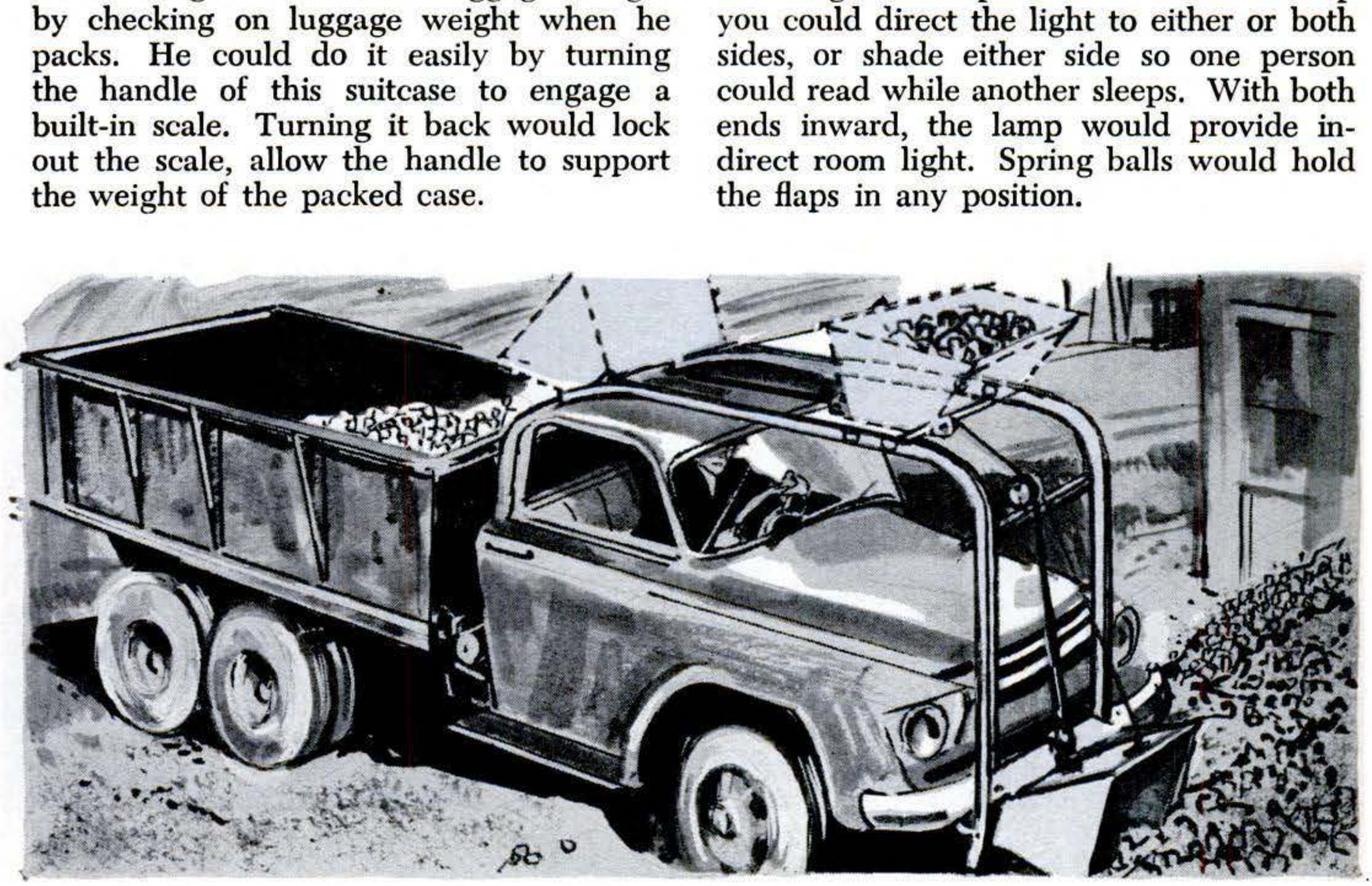
Handle scale weighs luggage. An air traveler might avoid excess-baggage charges by checking on luggage weight when he packs. He could do it easily by turning the handle of this suitcase to engage a built-in scale. Turning it back would lock out the scale, allow the handle to support the weight of the packed case.



Lampshade angles the light. By moving the hinged side panels of this bed lamp you could direct the light to either or both sides, or shade either side so one person could read while another sleeps. With both ends inward, the lamp would provide indirect room light. Spring balls would hold the flaps in any position.



Loader scoops from front. Suitable for one-man operation, this truck loader might simplify small-haul loading of gravel and similar cargo. The driver would maneuver his truck to push the scoop into the load, then winch the hopper-shaped scoop up and over the cab roof so it could tip its cargo into the truck.

The following patents have been issued on these inventions: **Ship raiser**—*No. 3,091,205 to W. Watson, Marblehead, Mass.;* **Baseboard anchor**—*No. 3,062,342 to W. R. Clements, Taylor, Mich.;* **Tree seat**—*No. 3,065,821 to R. E. Hundley Jr., Eagle Rock, Va.;* **Handle scale**—*No. 3,090,454 to C. L. Farrar and G. V. Marlow, Madison, Wis.;* **Directional lamp**—*No. 3,062,954 to R. L. Goolsby, Midwest City, Okla.;* **Truck loader**—*No. 3,074,570 to W. Venziani, Magliaso, Switzerland.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D.C., at 25 cents each. To write to an inventor, if the address given above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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Sky Cameras

America's cold-war sentinels

Photos taken six miles up can reveal almost as much about a factory or missile site as you'd learn on a guided tour

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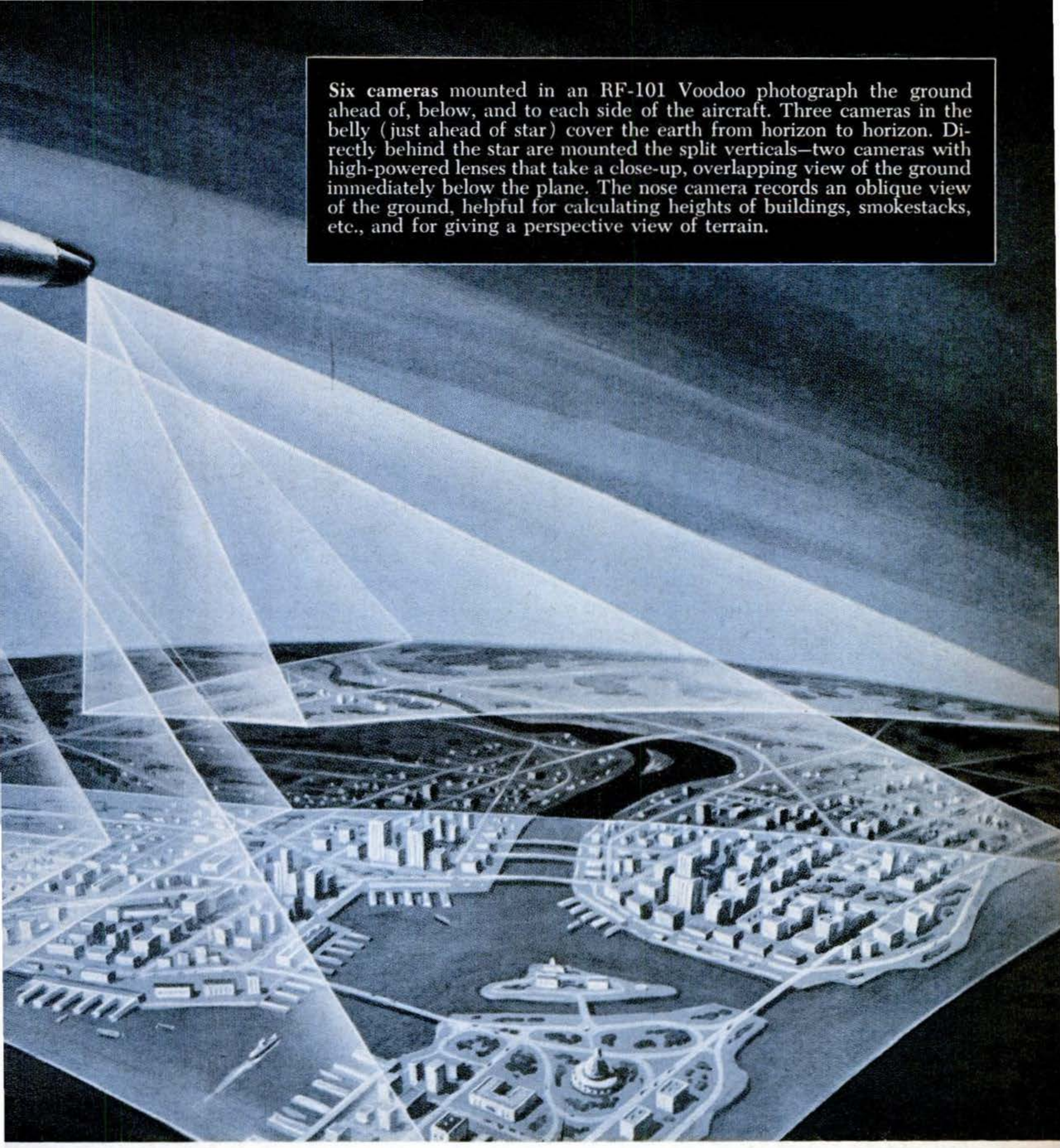

Six cameras mounted in an RF-101 Voodoo photograph the ground ahead of, below, and to each side of the aircraft. Three cameras in the belly (just ahead of star) cover the earth from horizon to horizon. Directly behind the star are mounted the split verticals—two cameras with high-powered lenses that take a close-up, overlapping view of the ground immediately below the plane. The nose camera records an oblique view of the ground, helpful for calculating heights of buildings, smokestacks, etc., and for giving a perspective view of terrain.

By C. P. Gilmore

EARLY one morning a year ago this month a phone jingled on the desk of McGeorge Bundy, one of President Kennedy's high-ranking aides. Bundy listened for a minute, strode to a small elevator, rode up to the First Family's private living quarters, tapped on the door, and walked into the President's bedroom. His too-urgent-to-wait message:

Aerial photos showed the Russians were building missile bases and assembling bombers in Cuba. Some 40 slim, 52-foot Red missiles capable of carrying a megaton each of atomic destruction were already mounted on portable launchers, aimed at the U.S. Additional sites capable of launching five-megaton

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monsters were being rushed to completion.

The chief executive reacted quickly, quarantined Cuba, demanded removal of the weapons. The Reds—surprised by the accuracy and completeness of U.S. evidence—complied, and a serious threat to U.S. security was removed.

The incident illustrates dramatically the value of one of our most vital cold-war activities: constant aerial reconnaissance of the world's trouble spots. Daily, scores of U.S. planes from bases around the globe photograph a large part of the earth's surface. Hundreds of skilled interpreters scan the acres of prints that pour in, pinpointing military maneuvers, industrial buildups, weapons emplacements.

During World War II and the Korean War, 80 percent of our military intelligence came from aerial reconnaissance. As Cuba illustrates, continuous surveillance of suspicious areas is just as vital now.

Aerial reconnaissance is effective because it provides a wealth of detail over tremendous land areas. Even from jet altitudes—30,000 feet and up—pictures of unbelievable sharpness and clarity show the fantastic detail of ripples on water, automobiles, even individuals. To see for myself and report on what today's advanced picture makers can do, I went to Syosset, Long Island, the headquarters of Fairchild Defense Products, biggest U.S. makers of aerial cameras.

Eye-opening experience. Albert Roltsch, a Fairchild executive, jabbed a finger at a photograph taken from 30,000 feet above Dayton, Ohio. "These 18 circles are baseball diamonds on a playground," he said. "Now let's see how good a photographic interpreter you are. Look at this print and tell where the baseball game is going on."

At first, it seemed an impossible job. Then I noticed something. A few rectangular dots were clustered around one diamond. Suddenly it struck me: automobiles. The diamond in use was the one surrounded by parked cars.

The most startling demonstration, though, was still to come. Roltsch slipped the picture under a microscope, focused, and stepped back. "Take a look," he invited.

The picture was striking. From six miles up, I could clearly see the foot-square home plate. I saw individual players on the diamond. My eyes swept past the bases; I saw two runners—one approaching second, the other nearing first. The second baseman's arm was outstretched—he had just thrown the ball. The first baseman reaching for the ball

How an expert reads an aerial photo

1 **Plant is operating** at full capacity because: a) parking lot full; b) coal being brought in by rail and stockpiled; c) cranes, bulldozers at work in stockpile; d) all water-cooling units in use.

2 **Two fuels run plant:** coal and natural gas. Presently burning natural gas since smokestacks show no smoke.

3 **Boiler-house design** indicates three boilers. Only two smokestacks, but positioning suggests plant was built for later expansion. New construction under way backs this conclusion.

4 **Ventilators** on turbo building show it has three generator rooms, hence three generators. Number further verified by arrangement of transformers outside.

5 **Electric power lines** can be traced on series of photos to determine cities and industrial areas served.

6 **Building measurements**—height of smokestacks, for example—plus analysis of construction, gives data for computing pounds of overpressure—hence size of nuclear weapon—that is needed to destroy plant.

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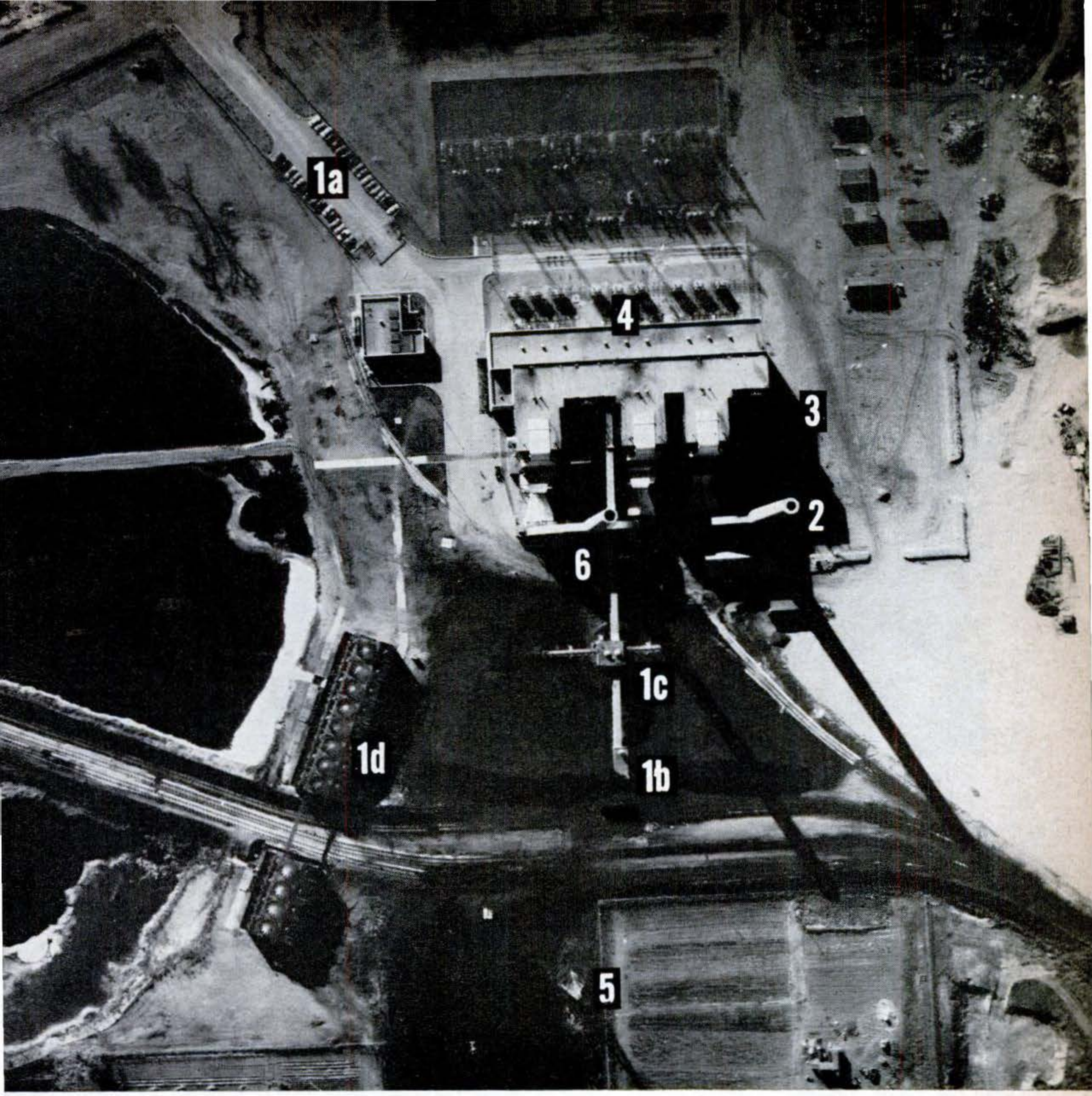

left no doubt. A double play was in progress.

The piece of high-flying hardware that took this picture is the high-acuity KS-25 camera system—325 pounds of precision equipment built to specifications a watchmaker would envy.

The KS-25, built by Fairchild for the Air Force, is completely automatic. The pilot simply holds his course and speed as the camera clicks away shot after shot —up to 600 or so nine-inch-square pictures (standard Air Force size) on a single loading. The automated picture taker not only senses how much light is present and sets its own exposure, it even decides *when* to take pictures.

Since most aerial photographs are studied through special stereoscopic viewers, pictures are taken in sequence so that each exposure overlaps the previous one by 60 percent. Thus, any given spot on the ground is photographed twice in rapid succession. Because the plane is moving, the two photographs are taken from slightly different posi-

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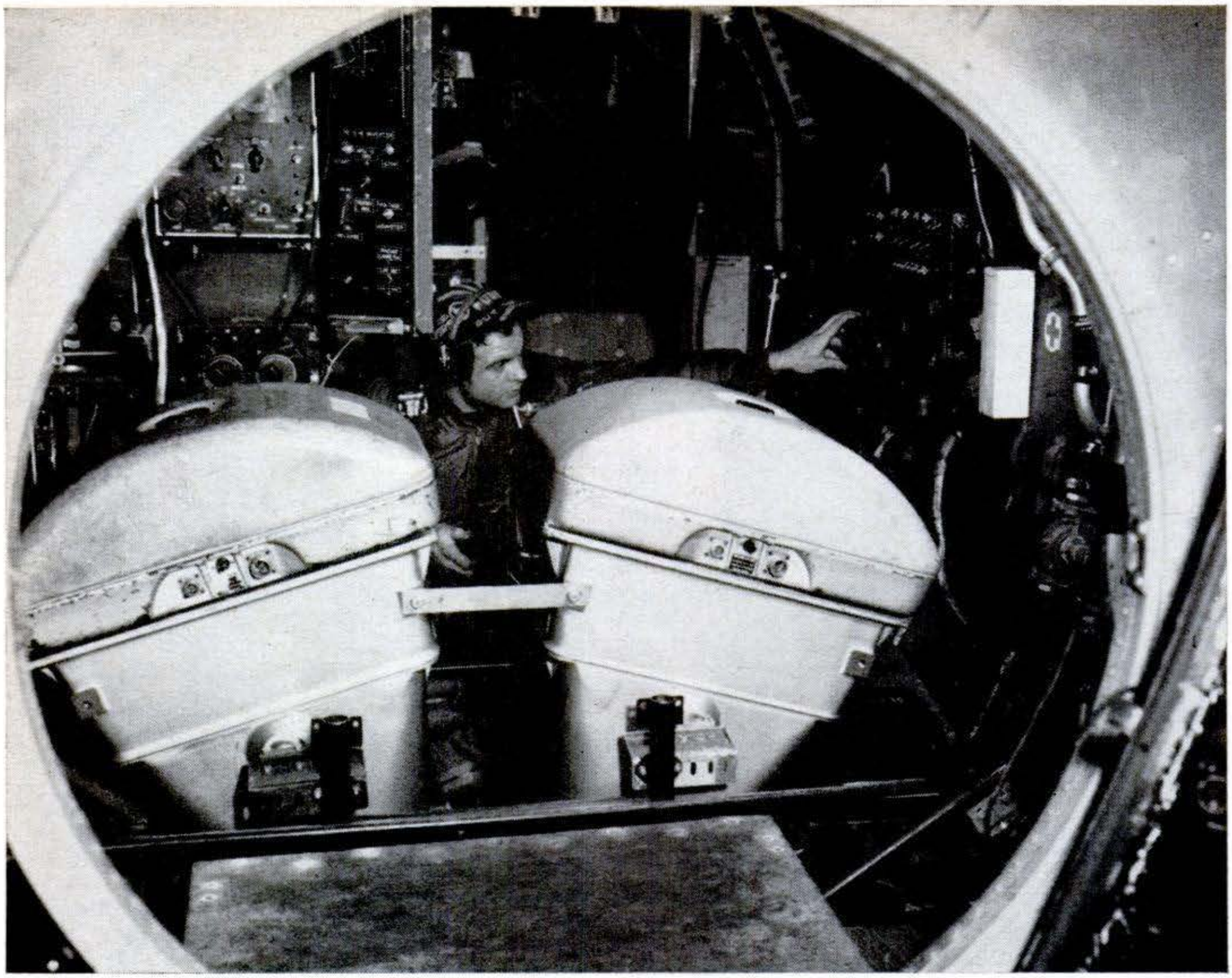

Big berthas of the camera world—Fairchild K-38s—take 9-by-18-inch pictures. The technician is adjusting the intervalometer. Feed the plane's speed and altitude to this gadget, and it decides how often the shutter must click to take overlapping pictures of the ground.

tions. Under a stereo viewer, the scene appears in three dimensions. Three-D movies work on the same principle.

An instrument called an intervalometer is built into the camera system. It figures out how often the shutter should snap to get pictures with precisely the required overlap. The pilot simply sets his altitude and speed on a control panel. A small computing circuit calculates how much of the ground each frame covers, and how often the camera should click.

Motion—and no blur. The KS-25 compensates for the movement of the plane, too. Built into it is what camera engineers call IMC—image-motion compensation. The principle is simple. The IMC device moves the film in the camera slightly while the picture is being taken, canceling out the relative motion between film and ground.

The KS-25, of course, is only one of many ingenious aerial cameras of widely different capabilities and advantages. The Navy CAX-12, for example (it shoots 70mm film, favored by the Navy), doesn't have the tremendous resolution of the KS-25, but it can snap 10 pictures a second. A fighter equipped with a CAX-12 can swoosh in at low altitude and shoot overlapping stereo shots from a few hundred feet.

And no shutter. Another camera uses no shutter at all. The film simply unrolls past the lens at a rate proportional to the plane's speed over the ground. Result: a continuous picture hundreds of feet long, covering thousands of square miles of terrain. One of the cleverest photographic machines is Fairchild's panoramic camera. A spinning prism below the lens scans the countryside and flashes on the film a horizon-to-horizon picture.

An aerial camera isn't much good, of

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course, until it gets off the ground. Our Voodoo—the RF-101 reconnaissance aircraft—is designed for just this purpose. This $2-million flying camera platform streaks across the sky at speeds close to Mach 2—more than 1,000 m.p.h.

It carries a half-dozen or more cameras, firing simultaneously. One in the nose shoots ahead to get a panoramic view. Three in the belly fan out to cover the ground below from horizon to horizon. In the tail are a pair of split verticals—big cameras with long-focal-length lenses that aim almost straight down. Between them, these two split verticals photograph in great detail a swath of ground directly below the plane.

Interpreters look first at the horizon-to-horizon films; when they see something interesting, they turn to the split-vertical shots to get the details.

What a PI can do. Perhaps even more striking than the fantastically sharp, detailed shots that modern recon cameras capture is the incredible amount of information that trained photo interpreters wring from these pictures. When I went to the Pentagon to talk about aerial re-

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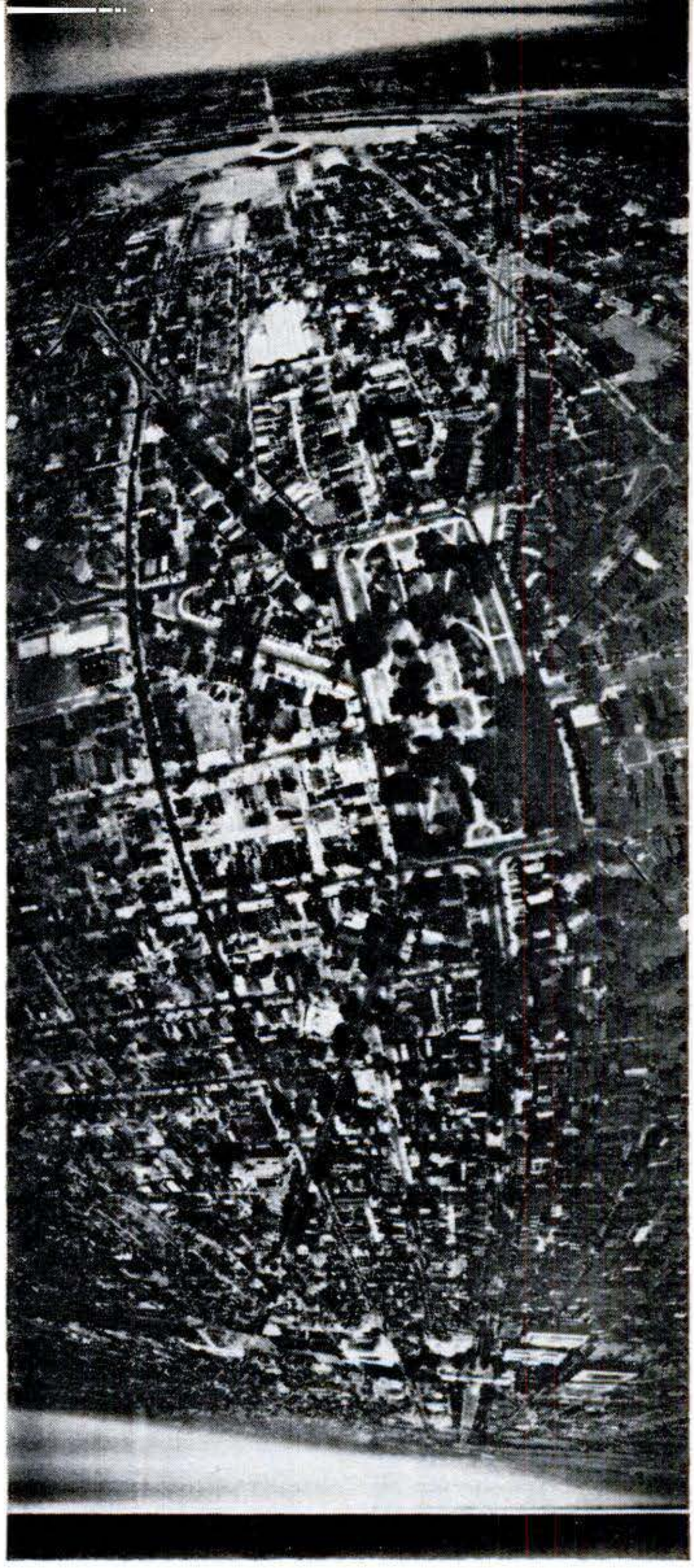
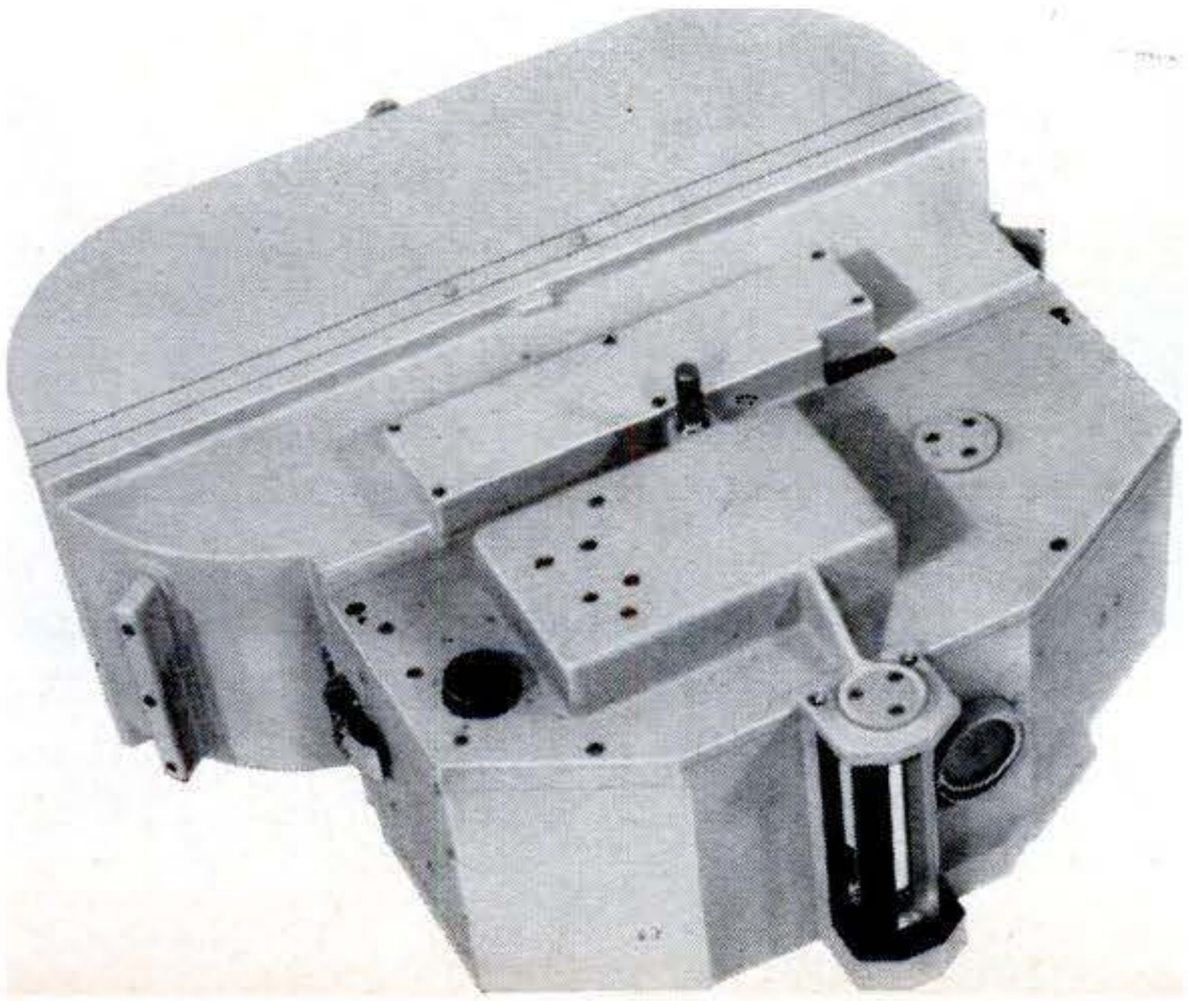
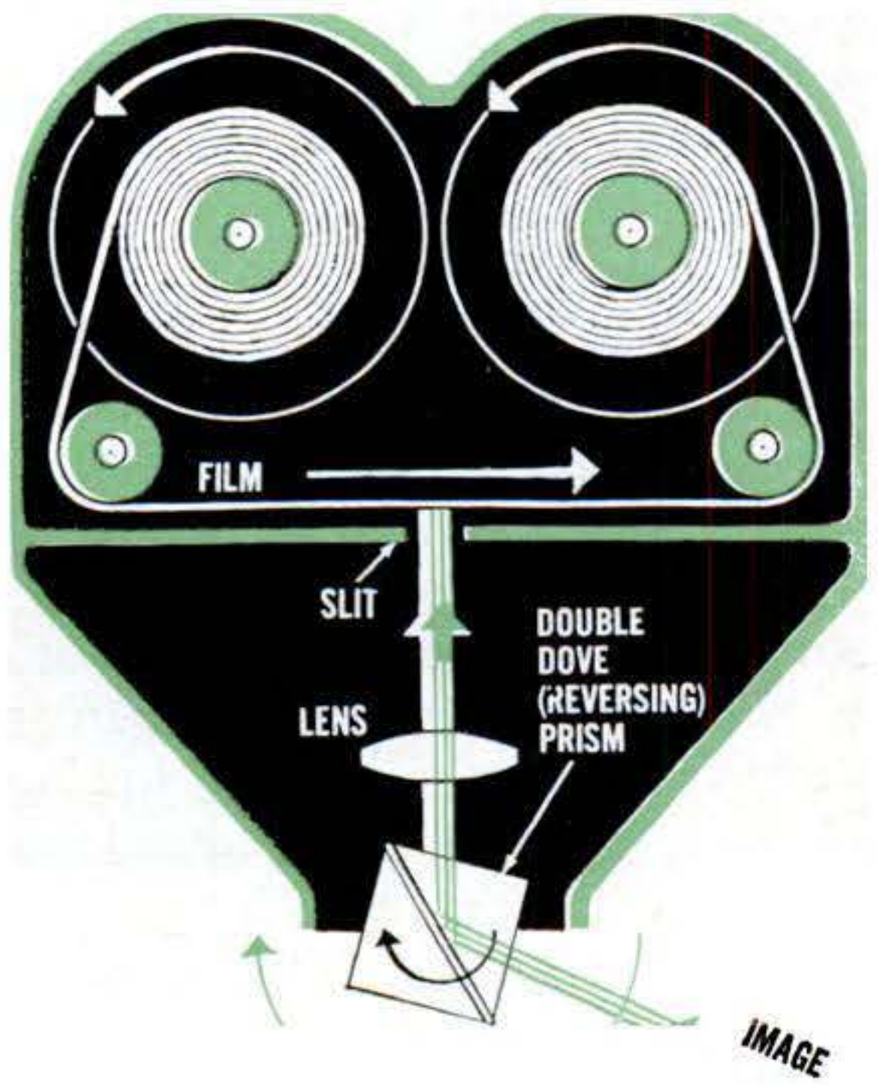


From horizon to horizon—in a fraction of a second

A spinning prism lens on this new Fairchild camera sticks out through the bottom of the plane. As it spins to take its 180-degree picture, it "paints" an image on the film, which is moving in synchronization. In the picture (above, right) you can see one horizon at the top, another at the bottom. Turn the picture sideways for a pilot's-eye view.





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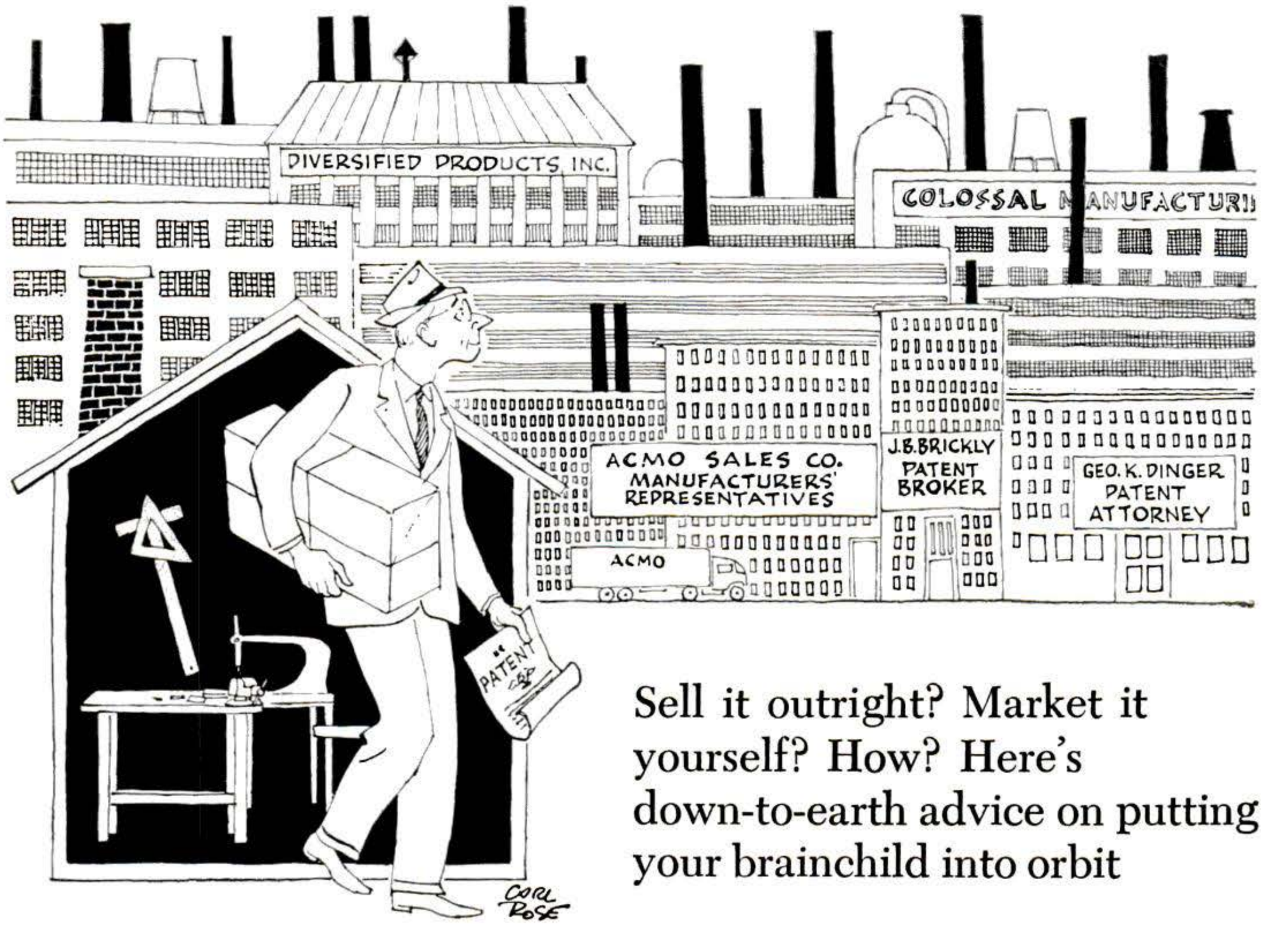

Sell it outright? Market it yourself? How? Here's down-to-earth advice on putting your brainchild into orbit

How to Cash In on Your Invention

By Norman Carlisle

WHEN George Breen, a young electrical-equipment salesman, moved to a Vermont farm with the idea that he'd make maple sugaring pay, he soon tired of the backbreaking labor involved in doing it as it had been done since the Revolution. Extracting sap from the trees and conveying it by bucket to the evaporating tanks was a tedious business. Breen, using his head instead of his back, decided to automate the process.

He rigged up an intricate network of plastic tubes that ran from tree to tree and ended up in the vat. Realizing he had an invention that others could use, Breen applied for a patent. Then he asked himself the question that plagues every inventor: "How can I sell it?"

Breen had heard that inventions were hard to sell, especially to big firms with their own research departments, but he boldly discussed his device with the company that had sold him the tubing—the giant Minnesota Mining & Manufacturing Co.

It promptly bought the rights to Breen's invention, and now markets it under the name of Mapleflo. Royalties flow into Breen's pockets as easily as the

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sap flows through the 20 miles of plastic tubing in his 65-acre sugar bush.

Was the ease with which Breen sold his invention to a big company—which holds hundreds of patents of its own—just a freak? Not at all. Only the fact that he sold it to the first company he offered it to is exceptional.

The odds are with you. How many inventions are actually sold and used? Statistics are hard to come by because the U.S. Patent Office keeps no records of what becomes of an invention after it's patented. But studies by the Patent, Trademark, and Copyright Research Foundation of George Washington University reveal that a suprisingly high percentage are actually sold or used. While authoritative estimates just a decade ago ran as low as 20 percent, a study by the Foundation indicates that between 55 and 65 percent of all recently patented inventions are actually used.

And the remaining 35 to 45 percent of unused ones include some that obviously had little chance of sale to begin with—like a recently patented bagel slicer (a bagel is a doughnut-shaped hard roll); a balloon-supported, flying landing field for rescuing stricken airliners; and an improved dowsing rod that uses copper tubing instead of the familiar "witching" stick. That unused category also includes "back-up" patents taken out by company researchers who have simply patented embellishments, which may never be used, on existing inventions.

What's the secret of selling an invention to a big company? The success

Sell to a big or a small company? The small one is probably more anxious for new inventions.

stories of independent inventors, research directors, patent attorneys, and invention brokers indicate that the trick is to offer the right invention. George Breen picked the ideal concern to approach because 3M had much to gain from marketing his pipeline sap-harvesting system.

The "big-company" products. Some inventions are, by their very nature, "big-company" products. Jim Robbins, the man who devised the coin-operated do-it-yourself dry-cleaning machine, knew from the start that only a big appliance maker could buy it and put it on the market; a small concern could hardly have coped with the manufacturing and distribution problems.

While he was working on his machine, Robbins and his lawyer studied various appliance makers. They picked two as their first targets. The second was Norge, which sent a team of top executives to the little Michigan town in which Robbins had built his sample machine. Norge bought it on royalty terms that promise over $2,000,000 for Robbins.

A few years ago, Leonard Marrafino, a Mount Vernon, N.Y., printer, and John Spero, a draftsman, joined forces to develop a "crazy" invention: a way to put stripes in toothpaste. By much tinkering they devised a tiny plastic gadget that goes in the top of the tube. When the tube is squeezed, coloring matter comes through the slots, making stripes in the toothpaste. The inventors decided that

What's the secret of success for the independent inventor? Offering the right invention.

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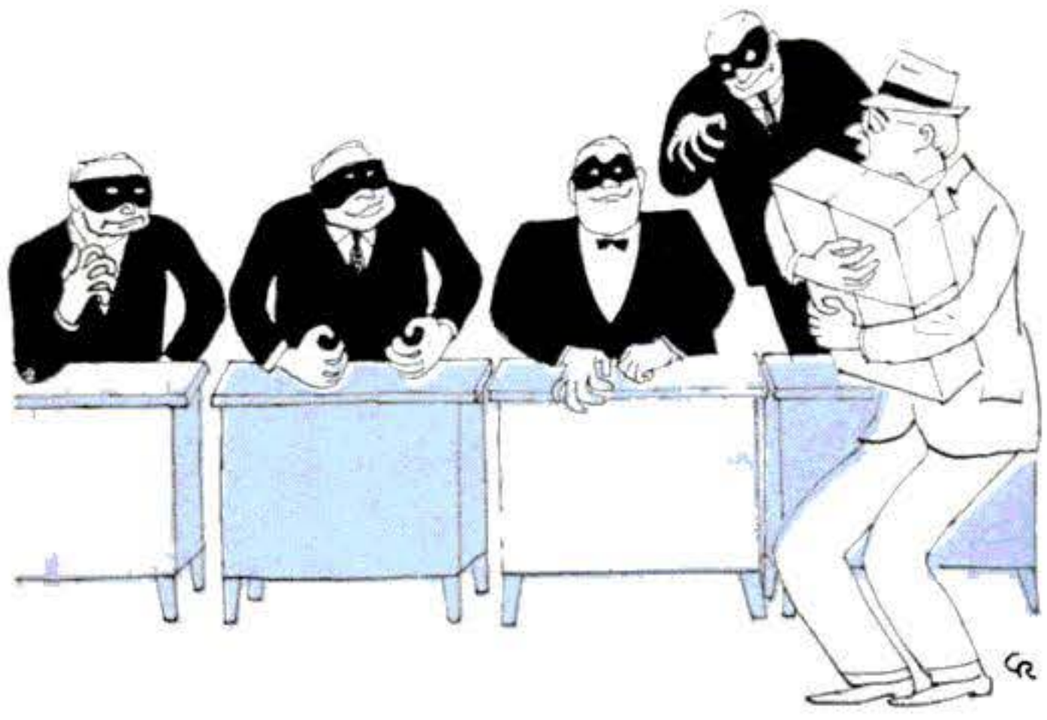

Do companies steal inventions? A myth, says an invention expert. It's cheaper for a company to pay royalties than to fight lawsuits.

no small company could make a go of distributing the novel toothpaste, and offered it to the pharmaceutical giants. Lever Brothers bought it. The result: Stripe.

While most big companies are receptive to the right offering, only a few inventions are really big-company naturals.

Think small. Aim for the littler fellows. "I generally seek out small companies," says K. O. Kessler, an invention broker. "The big companies rarely *need* an invention—lots of smaller concerns do."

Kessler cites cases like the bricklaying device developed by Henry Ruzza of Eau Claire, Wis. It enables a do-it-yourselfer to erect brick walls and maintain a level line. "No good for the big companies—but we found a small plant in Michigan that snapped it up because the firm needed something to keep its machines busy."

There are hundreds of similar examples. Dr. Robin Beach, a Brooklyn engineer who invented the Magic Wand, a simple wood-and-wire device for bleeding static electricity from industrial machines, could have sold to a big firm. Instead he decided on a small specialized one that he felt would really push his invention.

A small firm was also the choice of Frank Bellock of Chicago whose invention is a kidproof wall outlet, developed after his son received a bad shock when he thrust scissors into an ordinary outlet. Bellock picked a modest-size local company that needed specialty items.

When Dr. Robert Horton, a Minnesota physician, developed the Slumbertone, a small transistorized gadget that emits a sound soothing to a baby, he found the ideal maker—a small company already making a baby product, and which could easily handle another with its sales and manufacturing setup. The terms for the inventor were much more favorable than he could have obtained from a company in less need of his invention.

How do you find the company? Your local Chamber of Commerce will be eager to give you information about any firm that might be interested. Many trade associations will provide you with a list of members, and with information about which ones might be interested in your invention. A visit or letter to a field office of the Small Business Administration will get you advice about firms that might be prospects. You can get the "Directory of National Associations of Businessmen" by sending 50 cents to the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. "Thomas' Register," available in most public libraries, lists all U.S. companies by products.

It's not impossible to get firms to come to you. Classified advertisements in newspapers have attracted buyers. A man with a pharmaceutical process sold it for $200,000 through an ad in a New York daily. For a fee of $3 the Patent Office will list your invention in the "Official Gazette." The Small Business Administration puts out a "Products List Circular" in which, without charge, it will describe and picture your invention.

You can offer your invention to a company in person or by mail. If you've got a patent on it, the basic document, of course, is the patent application. A lot of inventors wonder about offering a patent-pending invention, or one on which they haven't even applied for a patent. You can offer either. Many companies will look only at patented or patent-applied-for inventions; others will con-

[*Continued on page 198*]

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Crossing gate on school bus

A safety gate mounted on the bumper of this school bus swings out hydraulically to keep children from crossing until the driver sees that all lanes are clear. Then he switches off a red light, swings the gate back, and permits them to pass by.

Superior Coach Corp., Lima, Ohio, makes the gate to fit either old or new vehicles.

Piggyback swimming pool

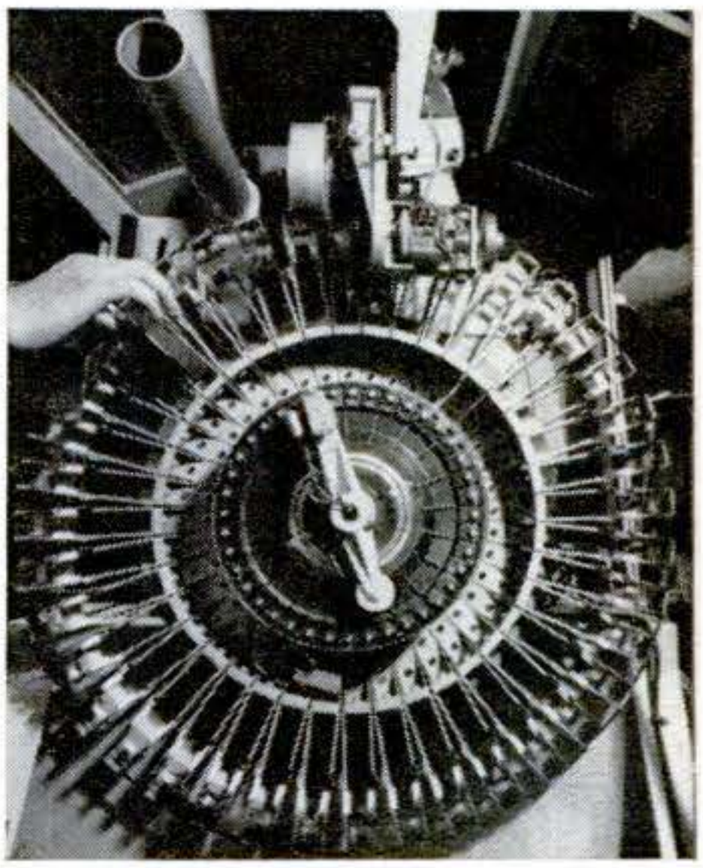
A swimming pool floating on the Seine in the center of Paris has been a popular haven for both citizens and visitors all summer. Here the 70-ton steel pool is shown being lifted from its transport barge for mooring near the Concorde Bridge. When the season ends this fall, the 50-by-165-foot pool will be decked to serve as a floating parking lot.

Here come jukebox movies

Latest thing to hit the jukebox-set at taverns and bowling alleys is movies: three minutes of sound film for a quarter. The screen looks like any 21-inch television set; the console under it resembles an ordinary jukebox with individual panels listing 40 titles and a slot for your coin.

You make your selection on the Cinebox, insert your coin, press the starter button, then sit back and enjoy the feature. A storage reel spins to the selected film. Threaded on a projector, it's reflected on the back of a rear-projection screen through a system of mirrors.

Cinebox, developed in Italy, is marketed by Cinevision Corp., Hicksville, L.I.



Inside jukebox, reels are held on vertical storage wheel behind projector. Only one is shown on rack, in playing position at top of photo.

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FROM RAZOR BLADES TO ROCKETS

Stainless steel, the miracle metal that won't rust, pit, or corrode, is finding hundreds of new jobs in industry, in space, and in the home

By Dag Fossen

NO NEED to throw away razor blades after one or two shaves. Blades that will give up to 20 slick shaves are now on the market.

The secret: stainless steel. This "noble" metal—the chemist's term for a substance that resists oxidation—doesn't tarnish, pit, or corrode. Invented more than 50 years ago, and long used mainly for its decorative appearance, stainless steel has suddenly found a host of new, and very practical uses.

Take a look in a modern kitchen, and you may well see an array of stainless-steel bowls and pans. Durable and easy to clean. Ditto for dozens of other kitchen items, from the garbage can to "silverware." Ditto for the kitchen sink. About a fourth of all sinks installed today are stainless.

What is stainless steel?

It's an alloy steel containing at least 11½ percent chromium. This much is needed for chemical reaction with oxygen, which results in the formation of an invisible protective shield around the metal. Unlike coated metals, stainless can be cut without harming the surface; as soon as the cut area is exposed to air, it is covered by this film.

Besides chromium, stainless steel often contains a number of other elements. Nickel is most often used, since it improves formability and corrosion resistance. Sometimes varying amounts of one or more elements such as vanadium, manganese, molybdenum, titanium, and columbium are added to increase machinability, hardness, or high-temperature resistance.

Metallurgists had been working on compositions containing chromium for almost 100 years. But credit for development of the first true stainless steels has been given to two Americans, Christian Dantsizen and Frederick M. Becket, and an Englishman,

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Harry Brearly. These men, working independently of each other, developed several practical alloys between the years 1911 and 1920.

From nonmagnetic to super-hard

Three kinds of stainless—called austenitic, ferritic, and martensitic—have been developed. The austenitic type, with 18 percent chromium and eight percent nickel, is most widely used. It is nonmagnetic, readily formable to exacting shapes, and most resistant to corrosion. Tensile strength in the annealed state is 90,000 p.s.i. compared with less than 50,000 for mild steel.

Ferritic steel, with a low carbon-to-chromium ratio, is magnetic, has good ductility, and is suitable for machining, drawing, spinning, and bending.

Martensitic steel contains up to 18 percent chromium as well as a high percentage of carbon for hardness. The only type hardenable by heat treatment, martensitic alloys are most often used where ductility and ability to hold an edge are most important.

As a group, stainless steels offer, besides corrosion resistance, high strength, resistance to oxidation at high temperature, hardness, ductility, and good creep properties. But not all these qualities can be found in any one type of stainless steel.

Common to all grades, however, is the accuracy and care with which they must be made. Ingredients must be absolutely pure. They must be added to the melt in exact proportions, at the right time and temperature. Because of the high melting points of chromium and nickel, stainless steel must be melted and refined in electric-arc furnaces.

In the fields of aeronautics and space, strength, lightness, and temperature resistance are the big factors. Structural members and engine parts made of stainless fly in every plane aloft today. In fact, it's stainless that makes the modern 2,000-m.p.h. plane possible. At these speeds, air friction raises skin temperature above 600 degrees—beyond the safe limits of aluminum.

Among the missiles using stainless skin is the Atlas rocket that boosted our astronauts into space.

In trains and automobiles

Ground transportation also has found uses for stainless. Recently the City of Philadelphia took delivery of 270 rapid-transit cars made primarily of this metal. Each car cost $7,000 more than cars made of more conventional materials. But because the new cars are lighter and easier to maintain, the city expects to save nearly $6,500,000 over the next 35 years.

Automobile bodies have been made of stainless steel, too, but only for promotional purposes. More serious use is found in the brightwork, especially those areas that are expected to take knocks, nicks, and dents, and still look good. Some stainless that you can't see serves a more vital function: in oil-control piston rings. And a number of models have stainless head gaskets. Mufflers and exhaust-manifold heat-control valves present the severest test of the metal in a car, where it must provide strength and corrosion resistance under high temperatures.

One unexpected use for stainless cropped up when Eastern Airlines found that the aluminum steps on its aircraft loading ramps were being torn up. The blame fell on women's spike heels, which exert a pressure of some 2,000 pounds per square inch. The entire weight of the wearer is concentrated on an area comparable to the head of a thumbtack. Aluminum couldn't take the abuse.

Stainless steel could.

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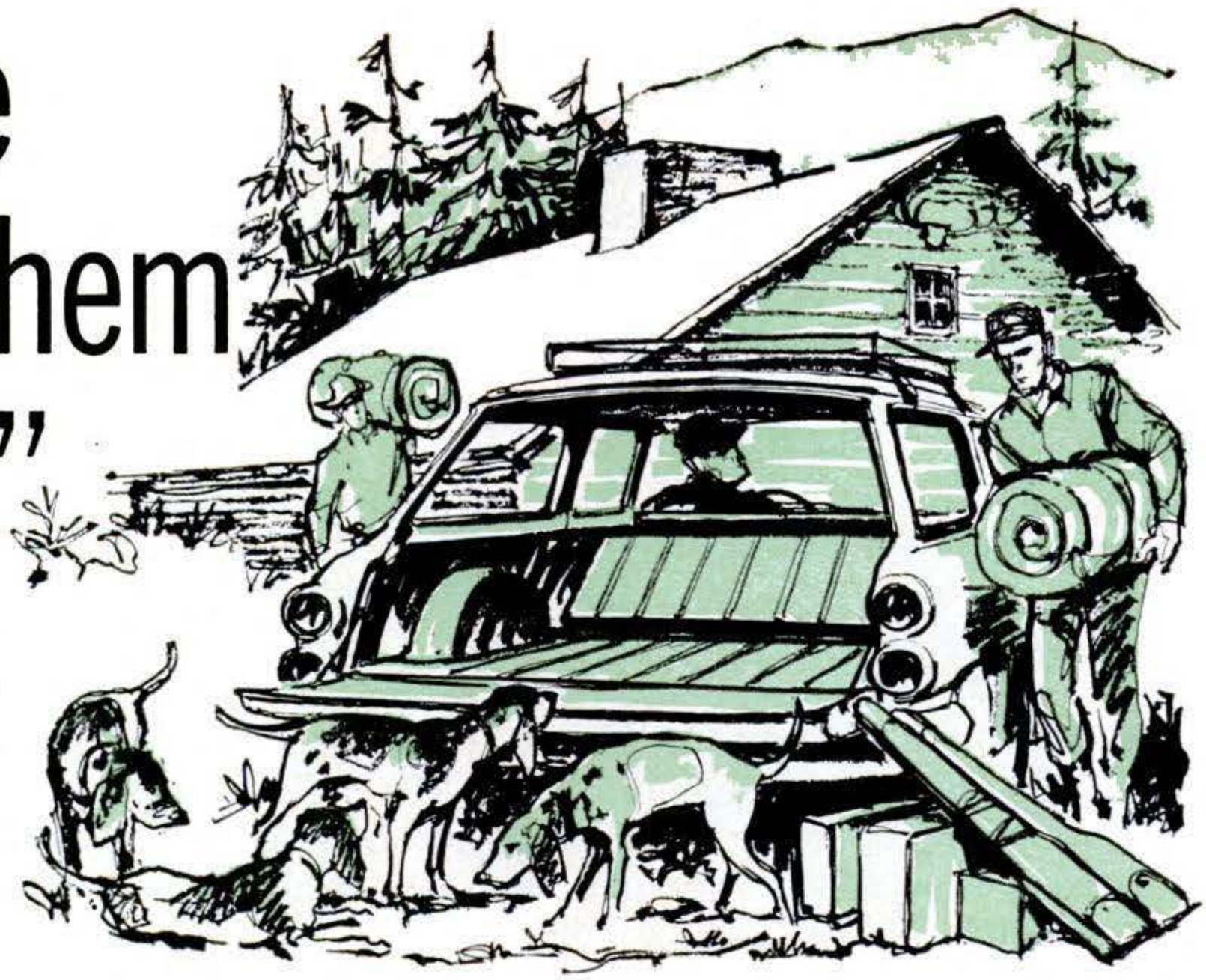
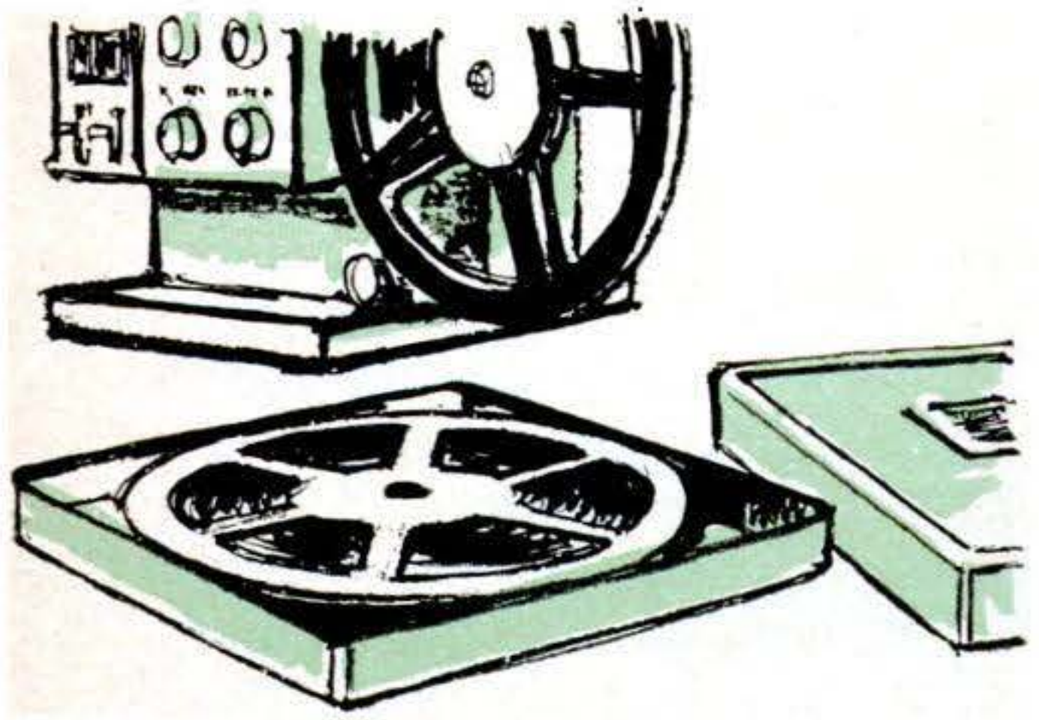
"I'd like to see them make..."

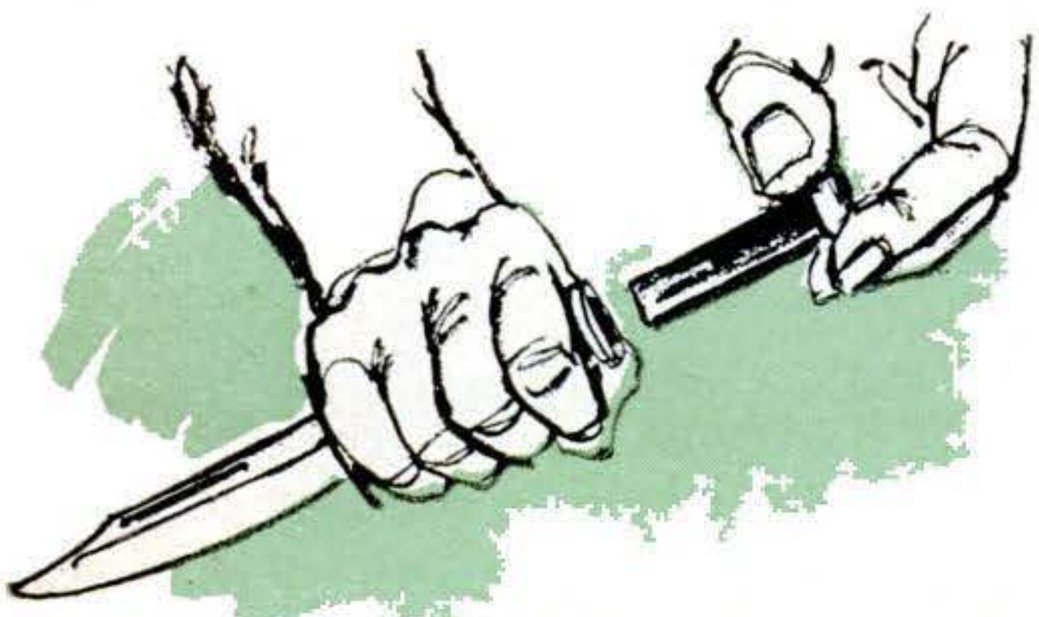


A motorized seat back in station wagons so you wouldn't have to struggle with latches and hooks every time you wanted to make extra load space.—*Phil Glotzbach, Kettering, Ohio.*

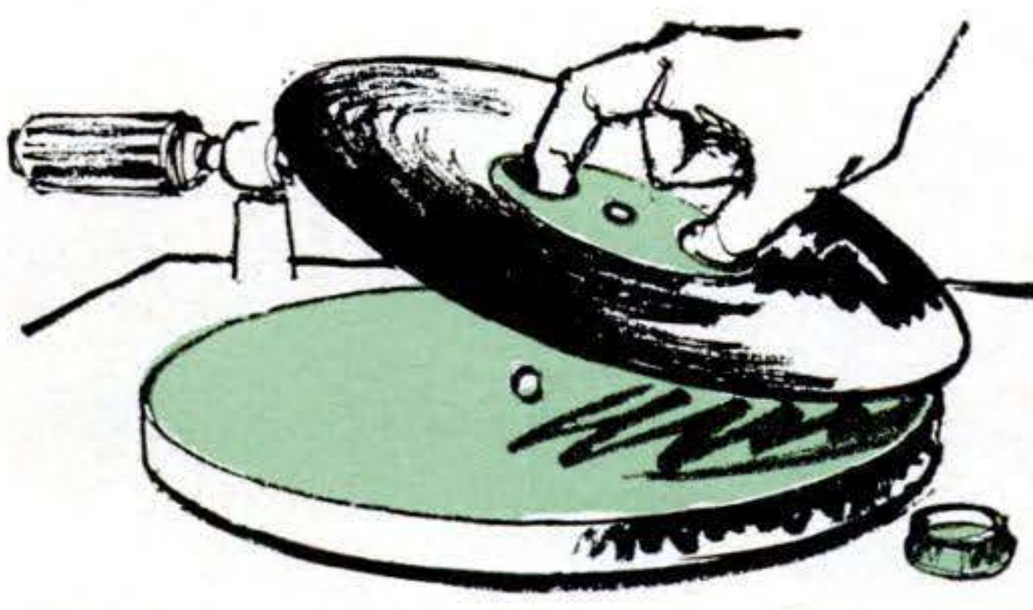


Movie reels in square cans for upright storage on shelves. They wouldn't roll, and they'd be easier to remove and replace than stacked cans. —*A. R. Tanner Jr., Poughkeepsie, N. Y.*

Bricks with protrusions at the sides to be used as spacers. They'd make it a lot easier for an amateur laying bricks to keep each course level. —*Ben T. Sheppard, Columbus, Ga.*



Hunting and camping **knives** that carry their own whetstone in a recess in the handle. Then you'd never be caught in the woods with a dull blade.—*W. L. Adams, E. Syracuse, N. Y.*



Fingergrip holes at the center of phonograph records. When loading or unloading such discs, the sound-track grooves would get less handling.—*E. J. Monjack, Chicago Heights.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's *yours?* We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 10017. Write your name and address clearly. Contributions cannot be acknowledged or returned.

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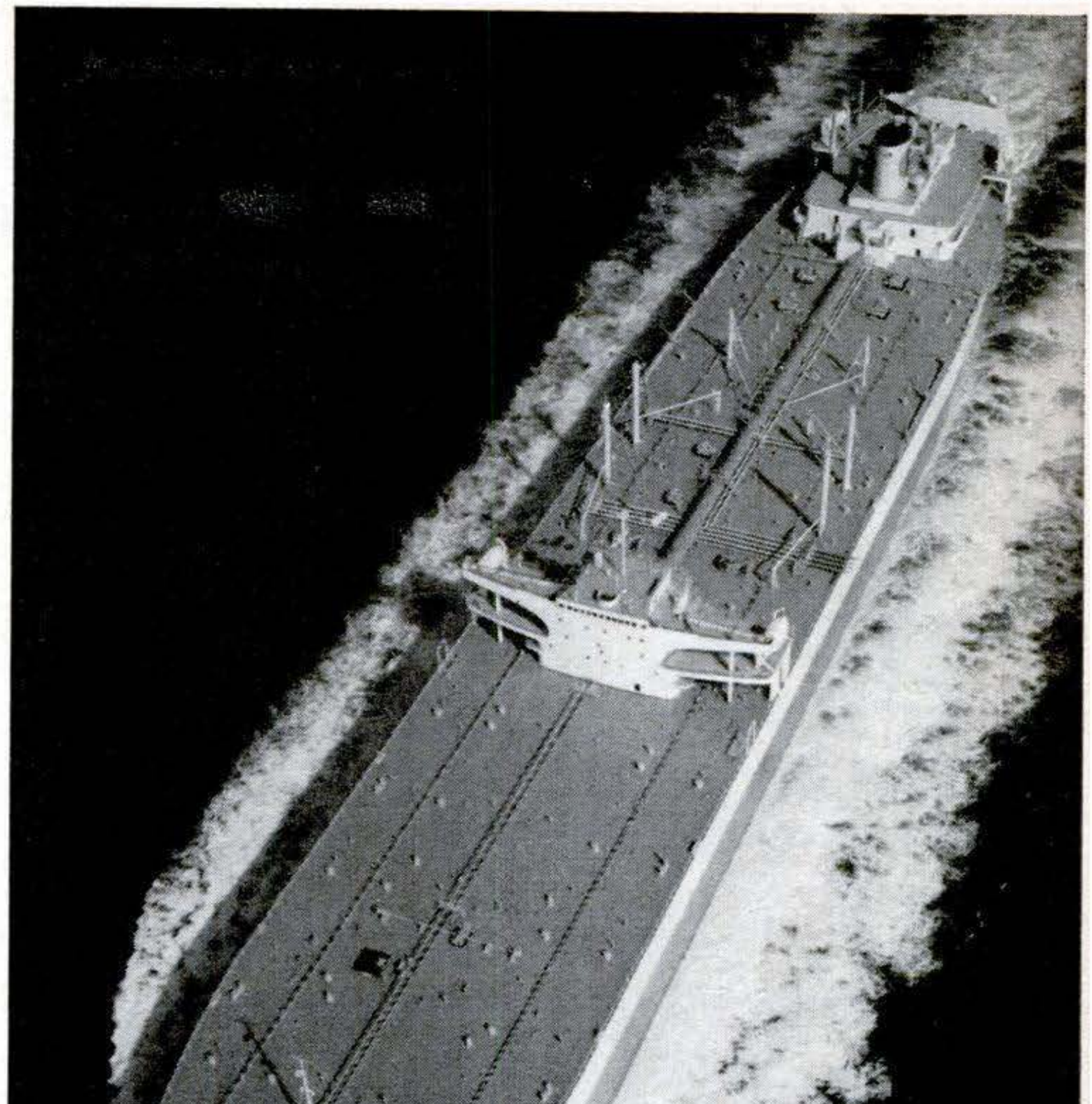
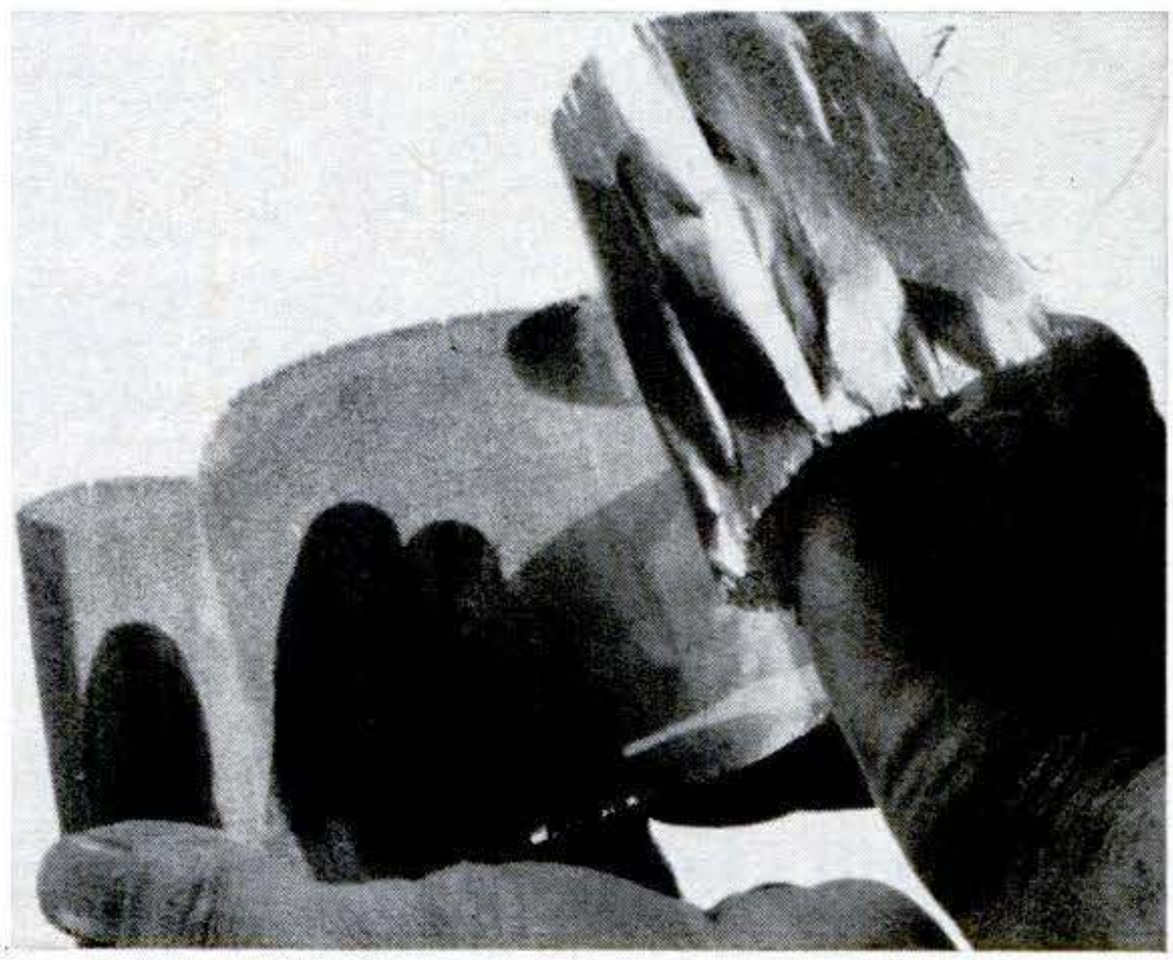
Giant tanker hauls oil from Near East

Japan's huge Nissho Maru transports more than a million barrels of crude oil on each trip from the Persian Gulf fields to the big Tokuyama Bay oil refineries.

A 132,000-ton tanker, world's largest, she dwarfs the 88,500-ton supertanker Naess Champion [PS, Mar. '63], and her 954 feet, 9 inches stretch her longer than the U.S.'s biggest, the 106,500-ton Manhattan.

Built of 1.5-inch plate, the behemoth was completed in less than a year at the big yards of the wartime Japanese navy. She is driven by a 28,000-hp. steam turbine, has a maximum speed of 17 knots under full load.





Steel you can see through

About half the thickness of a human hair, the strip of tin plate at left is basically the same kind that protects your tomato juice.

U.S. Steel scientists turned out this sample using a new rolling process. It can also be made opaque and may one day become commonplace for tin cans.

But how practical it would be to be able to distinguish peas from beans on the pantry shelf after baby strips off the labels!

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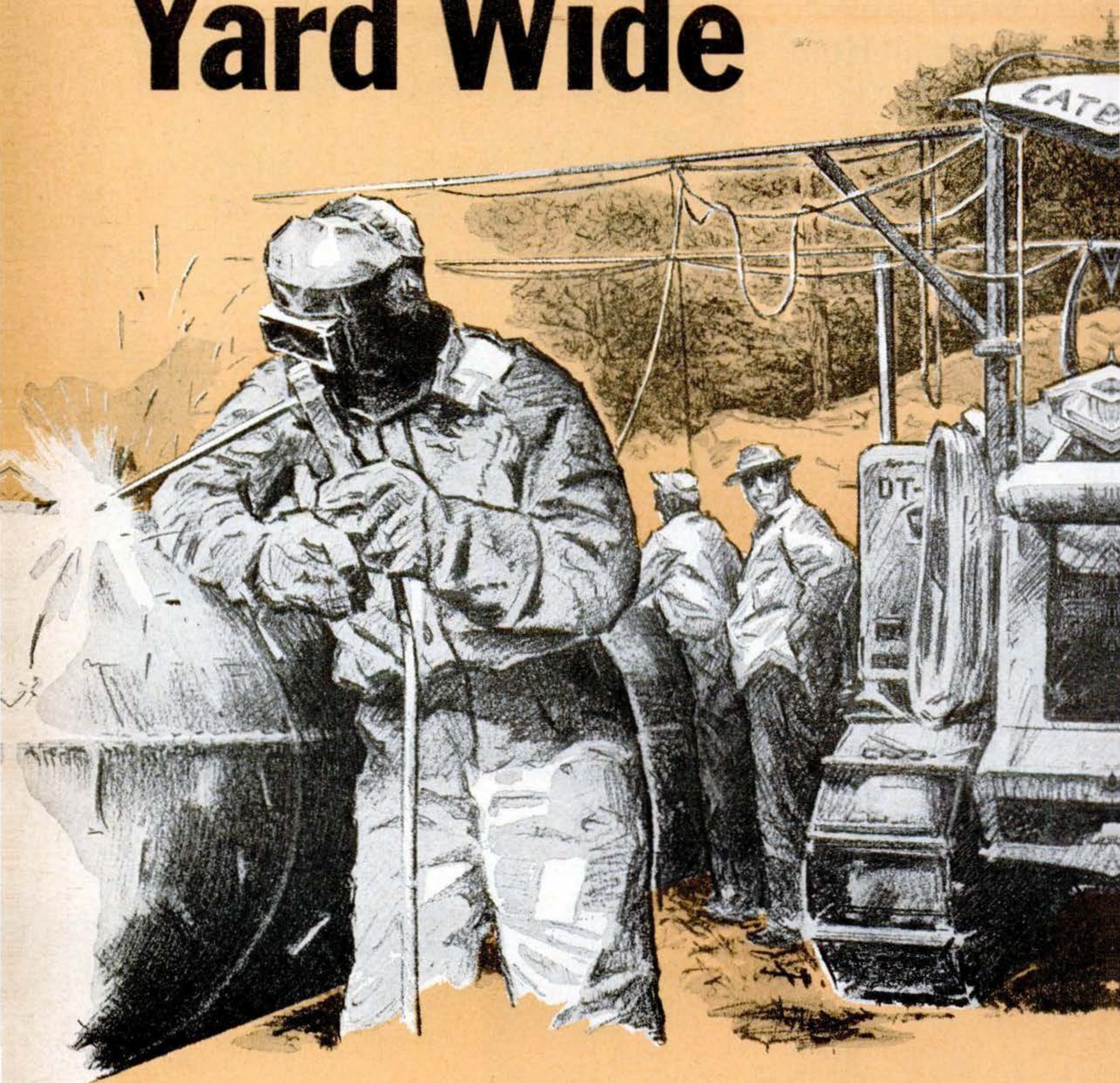
All Steel and a Yard Wide



. . . and 2,600 miles long. That's the giant Colonial pipeline. Early next year, 25 million gallons a day of petroleum products will start pouring through it

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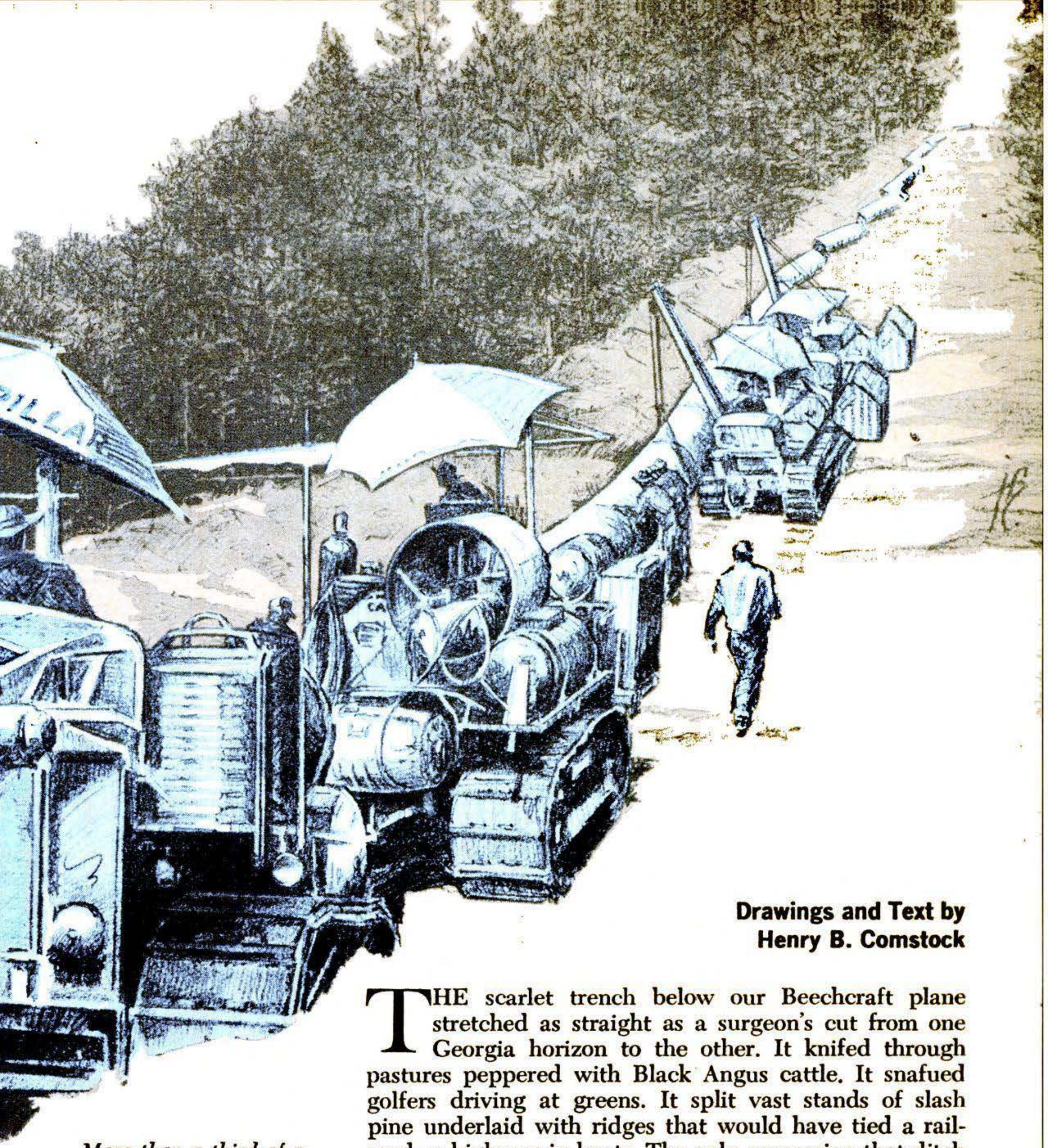

Drawings and Text by Henry B. Comstock

More than a third of a million 40-foot joints are being welded together to form the Colonial pipeline's 2,600 miles of main stem and spurs. Sharp crews with modern field equipment handle better than two miles a day.

THE scarlet trench below our Beechcraft plane stretched as straight as a surgeon's cut from one Georgia horizon to the other. It knifed through pastures peppered with Black Angus cattle. It snafued golfers driving at greens. It split vast stands of slash pine underlaid with ridges that would have tied a railroad or highway in knots. The only concession that ditch made to the landscape was a succession of roller-coaster grades.

This was my first look at the costliest single construction project ever financed by private industry—the $360-million Colonial pipeline now being pushed between Houston, Tex., and the New York harbor area. By early 1964, more than 25 million gallons of refined petroleum products a day will be pulsing through the huge arterial system's 1,600-mile main stem and 1,000 miles of spurs.

Get that phrase "refined petroleum products." Time

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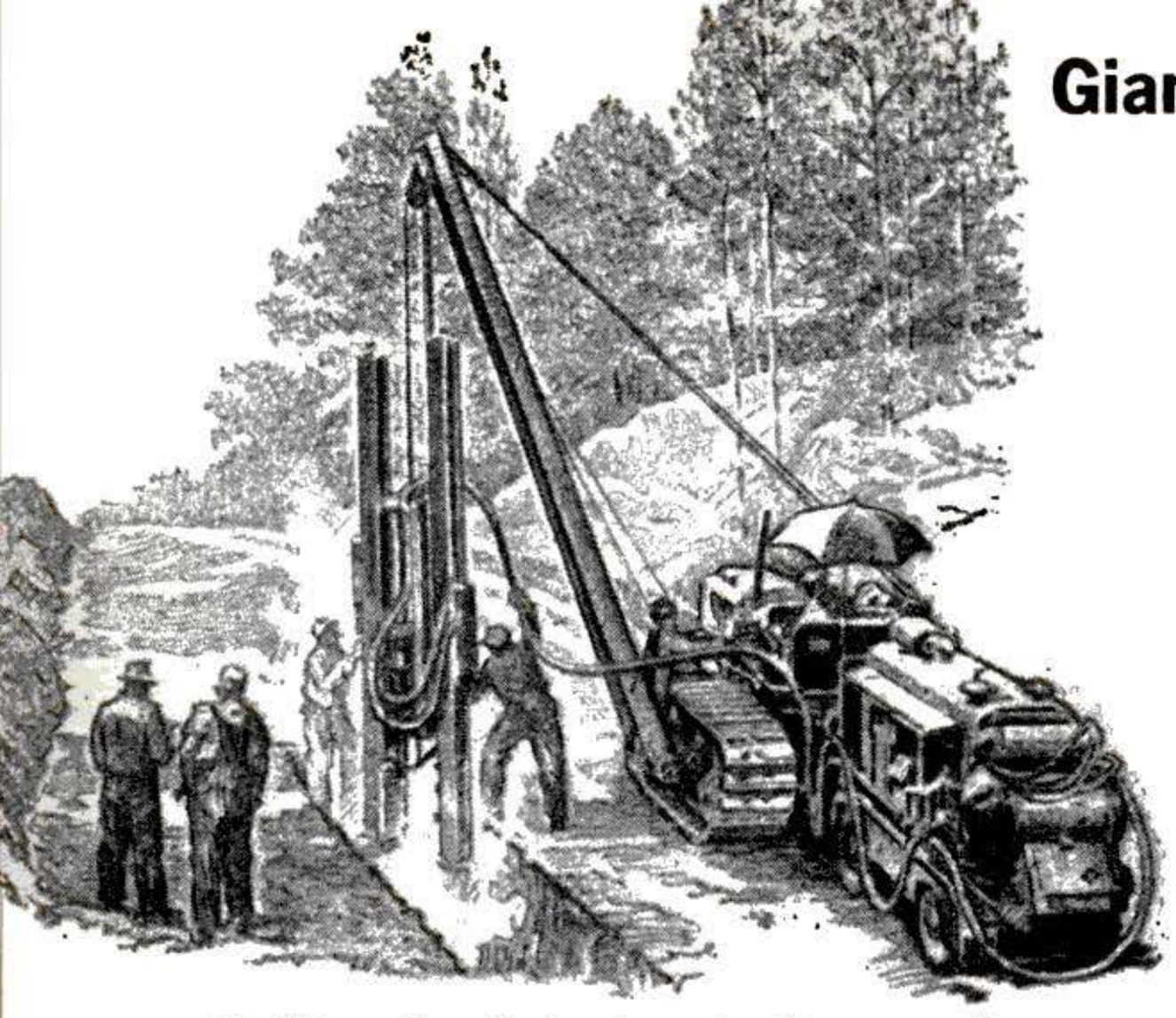


Drilling shot holes for pipeline trench in hardrock country: Powder monkeys may open up 1,000 feet with a single blast. Area is then backfilled and reopened with a ditching machine, producing clean-walled excavation.

was when all oil pipelines were relatively simple plumbing jobs, carrying crude from the wells to "crackers"—which broke the oil into components, such as gasoline—spotted near big markets.

Ironically, the closer you were to an oil well, the higher the transportation cost to get gasoline back to you!

The Colonial eliminates this backtracking. Like a number of smaller lines built in recent years, it will handle finished products pumped into it from refineries right in the oil country. Unending "cuts" of diesel, fuel oil, kerosene, and regular and premium gasoline will surge through the steel labyrinth to distribution points in 13 states.

Dispatchers will sit at consoles, controlling the flow. Electronic sensing devices will tell them when products are approaching a trunk-line or branch-line junction. With this setup, cuts can be shunted around like trains.

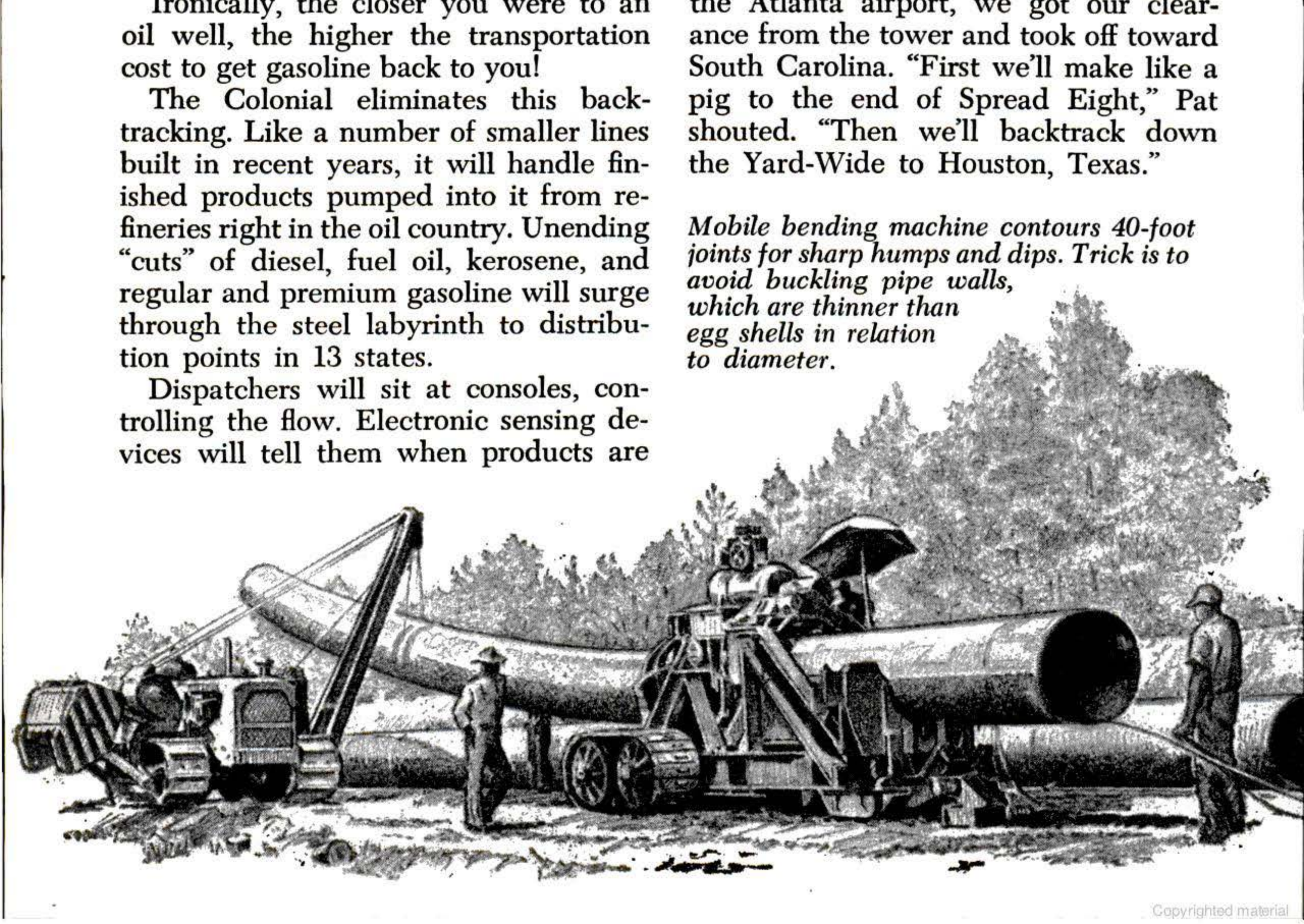
What about the mingling of different products where one cut follows another? Actually the interblend is small. For in a line kept full under positive pressure, the fluids behave almost like solids. The limited amounts of mixed stuff will be bled off and refined.

As a clue to the Colonial's amazing size, it will take more than nine million barrels just to fill the line. The system's initial 27 pump stations will be capable of pumping products at the rate of 800,000 barrels a day.

Pipeline lingo. When I tracked 800 miles of the Colonial's main stem by plane, car, and motorboat, the most impressive part of its 500,000 tons of steel was being tucked into Southern scenery. My guide for the inspection tour was a pipeliner from Texas who pilots his own Beechcraft with enthusiasm. At his request, I'll only call him "Pat."

Five minutes after he'd met me at the Atlanta airport, we got our clearance from the tower and took off toward South Carolina. "First we'll make like a pig to the end of Spread Eight," Pat shouted. "Then we'll backtrack down the Yard-Wide to Houston, Texas."

Mobile bending machine contours 40-foot joints for sharp humps and dips. Trick is to avoid buckling pipe walls, which are thinner than egg shells in relation to diameter.



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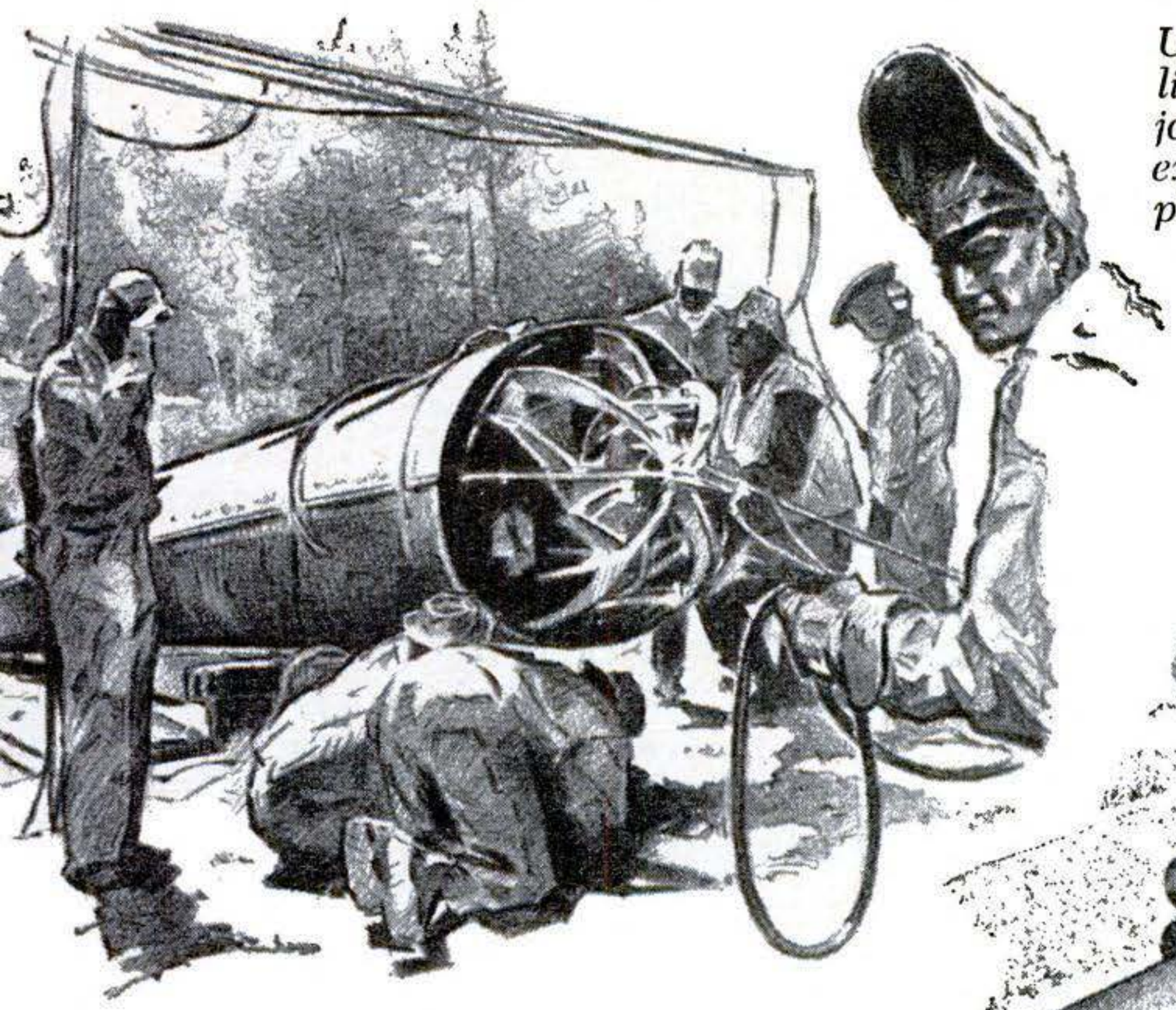
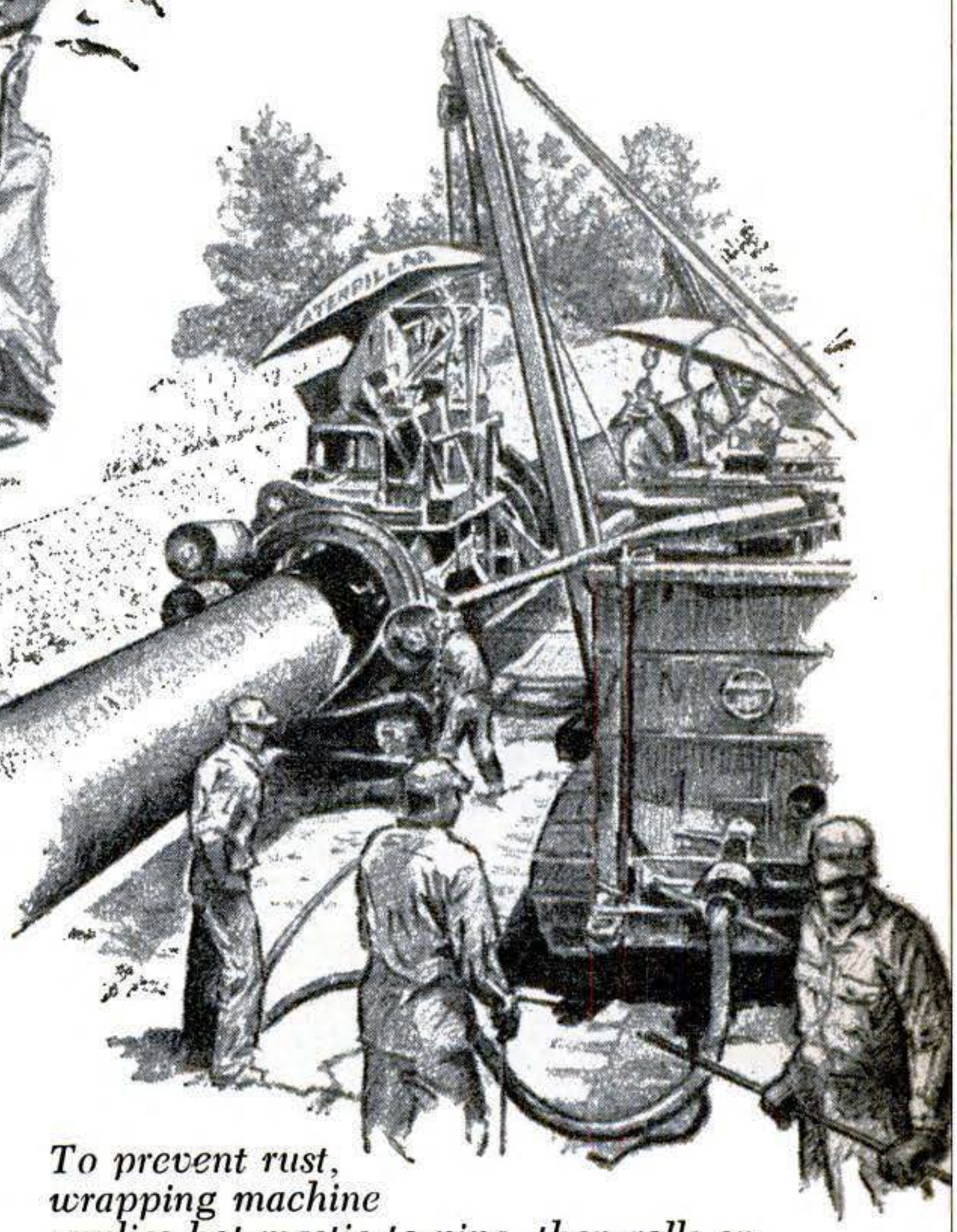
join man's brains to fulfill your demand for fuel



Umbrellalike clamp in mouth of line guides successive pipe joints into position. Then it expands, locking ends in place for welding.



To prevent rust, wrapping machine applies hot mastic to pipe, then rolls on 18-inch-wide ribbons of asphalt felt. Colonial pipeline is expected to last 75 years.

Already I had three questions.

"What's the Yard-Wide?"

"Nickname for the Colonial. It's catching hold like 'Big Inch' did some 20 years ago."

"How about a spread?"

"That's a work section roughly 100 miles long, assigned to a single contractor. Each calls for up to 500 men and several million bucks' worth of equipment."

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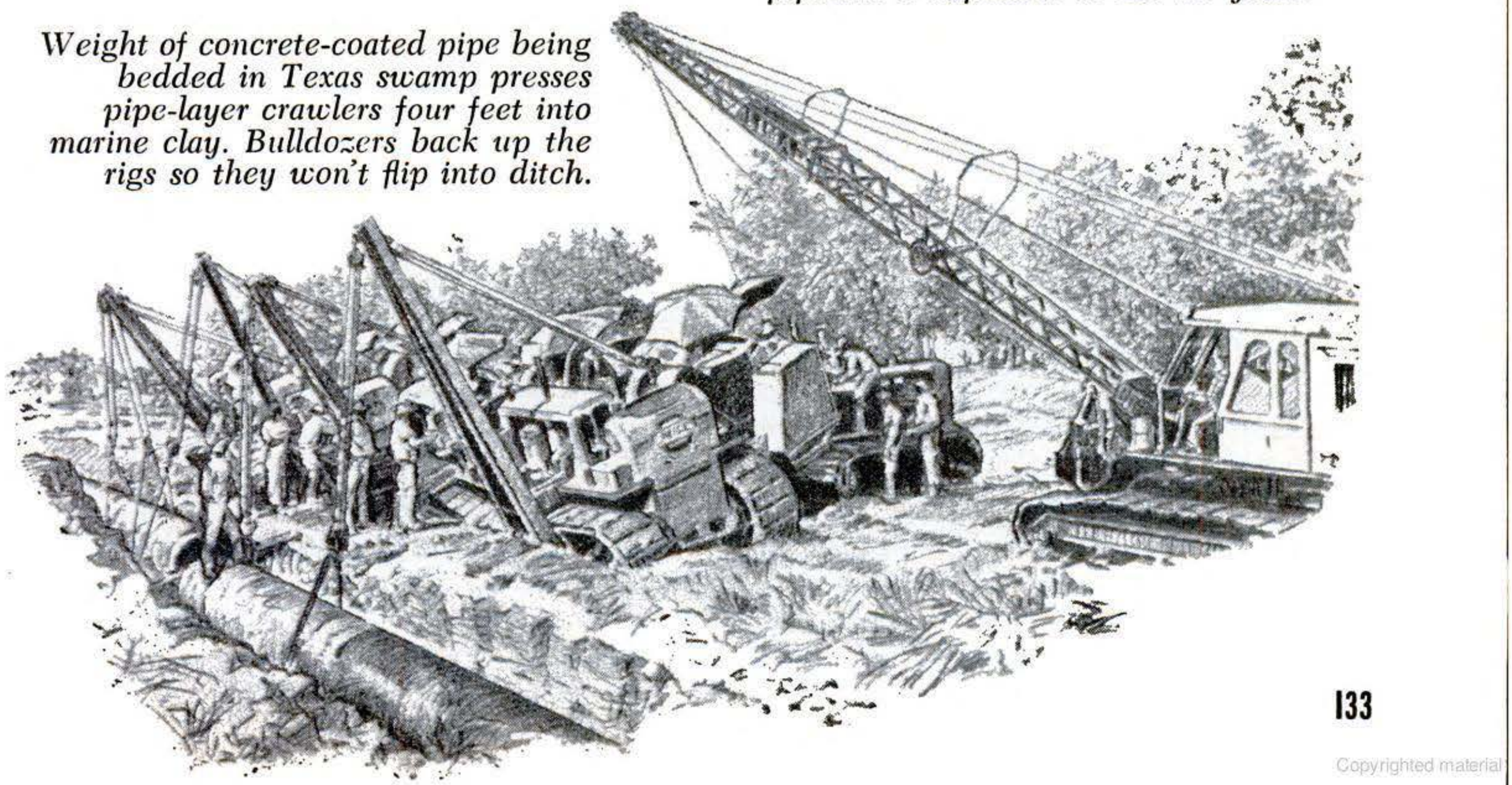
Weight of concrete-coated pipe being bedded in Texas swamp presses pipe-layer crawlers four feet into marine clay. Bulldozers back up the rigs so they won't flip into ditch.



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"And a pig?"

Pat laughed. "The inside walls of any pipeline have to be kept clean. The gismo that does the trick may be a couple of plungers with brushes and knives between them. Or it could be a big rubber ball hauling a pair of scrapers. Whichever type, it's placed in a line at a trap and pushed to the next station by the fluid behind it. If you stand on the right-of-way you can hear those outfits squealing underfoot. That's why we call them pigs."

Pat had a disquieting way of using the wingtip on my side of the cockpit as a pointer. When we whooshed over the Savannah River he aimed it straight down. "That boat in midstream," he said, "is drilling shot holes for the biggest show in these parts since 'Gone With the Wind.' Next week they'll open the whole river bottom with one blast. This setup must be cradled in trenches, even under water."

We'd just completed a 180-degree turn and were on our way to the Gulf. "When we get into Mississippi," Pat explained, "I'll take you downstairs for a closer look at operations."

One spread after another slipped under us, their parades of men and machines all looking the same. The work pattern ran like this:

1. Clear a right-of-way 75 feet wide.
2. Blast and claw out a four-by-six-foot trench, well to one side of a centerline.
3. Truck in 40-foot lengths of pipe, or "joints," and set them end to end on wood skids beside the excavation.
4. Weld the joints together.
5. Wrap the line to prevent rust.
6. Tuck it in the trench and crown it with backfill.

Concrete kimonos for river burials. In western Alabama the job grew rougher. We watched the Yard-Wide buck a succession of lazy rivers. At one location on the Black Warrior, a string of joints was being readied for an underwater pull.

The assembly had been bonded along one bank and coated, first with a protective layer of mastic, and then four inches of concrete. Without that concrete kimono, weighing 13½ tons to the joint, the pipe could pop back to the surface even after it was pumped full of oil. Supported by floats, the whole string was about to be hinged like a giant pasture gate from one shore to the other.

Farther west, we found what we'd been looking for—an armada of rigs laying in a stretch of line close to a highway. We circled back to an airport, staked down the plane, and drove to the site. In the hour it took us, those outfits had bedded 1,500 feet of pipe. That adds up to 2¼ miles a day.

To maintain the whirlwind pace, the contractor handling this Number Four Spread had combined a smart wrinkle with some highly specialized equipment. Instead of making all welds on location, he was bonding pairs of joints on a mechanized assembly line in a nearby supply yard. This cut field work in half.

What was left still made a good show. Up front, eight Caterpillar pipe layers and four mobile welders were playing a game of leapfrog. First a quartet of boom-equipped rigs picked up a double joint and butted it against the already welded string. There were no collars or flanges to make aligning easy. Instead, a self-propelled machine not unlike an umbrella frame sat in the open mouth of the line.

Once the double joint had been slipped over it, this internal clamp expanded, locking everything in place. A crew of electrode artists quickly girdled it with three welding beads. Meanwhile the other tractors clanked around the operation to tie on the next double length. At the same time, the clamp released its grip and rumbled forward through the pipe to give them an assist.

Outwitting nature. Farther down the line, a zany machine was inching, crab-fashion, along the top of the Yard-Wide. Its operator sat like a rajah in his elephant howdah, pulling knobs and levers under a big umbrella. This was a coating-and-wrapping rig. Its chore was to

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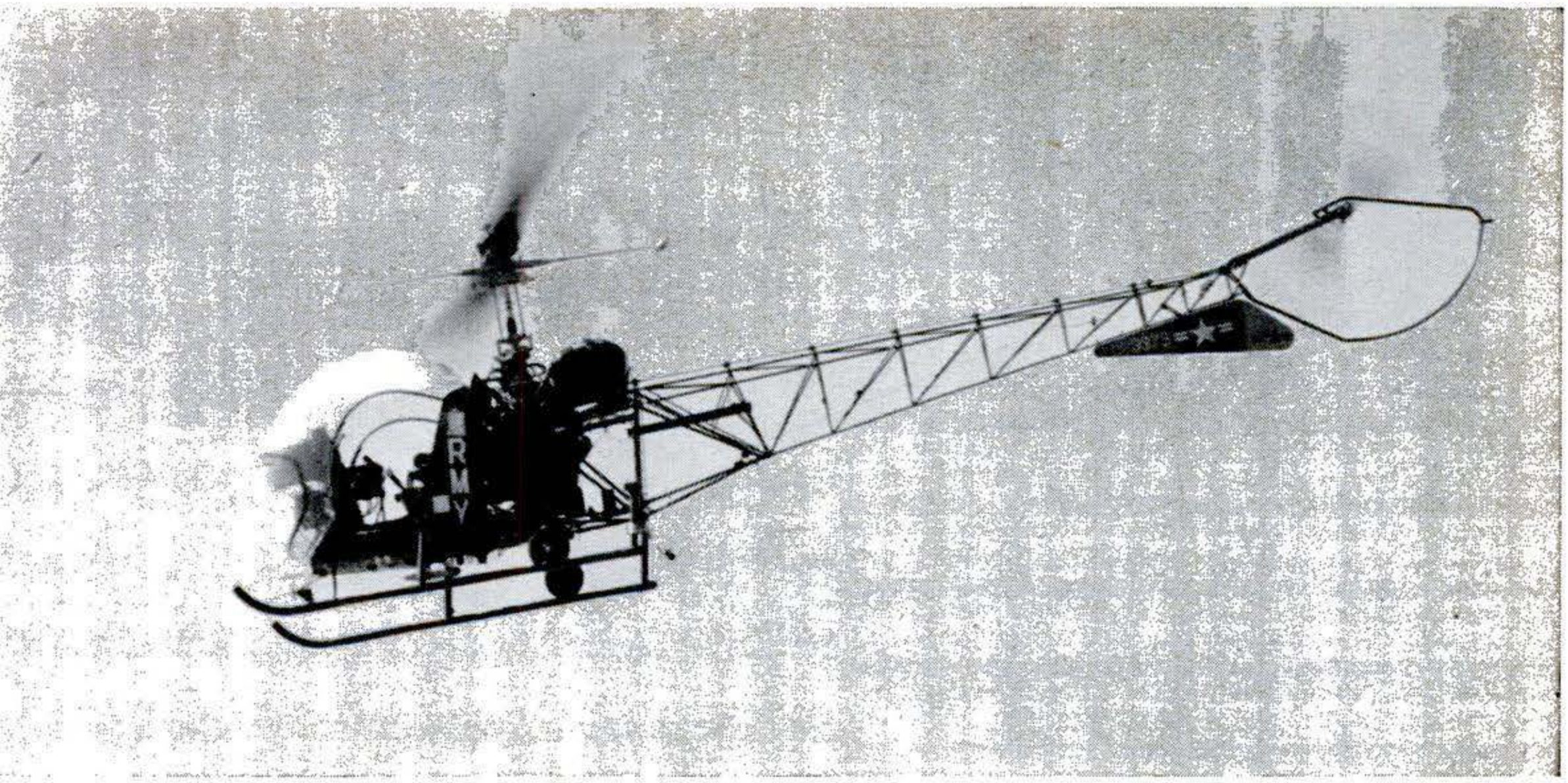

Helicopter flies by remote control

Look closely—there's no pilot in the cabin of this "bailed-out" 11-year-old Army helicopter. Instead, it has been fitted with radio controls developed by Bell Helicopter so it can be operated by a ground unit. It's shown flying unmanned at 2,000 feet above China Lake, Calif. The equipment can be put in any old copter for decoy use, reconnaissance, supplying troops, or dropping missiles on submarines.

Money vest is tamperproof

A dressy waistcoat, approved by a tailoring magazine and Scotland Yard, has been designed for British bank messengers. It's banditproof, blackjackproof, knifeproof, and bulletproof. Finished in stylish cloth, it is lined with steel mesh, laced with a steel chain, and secured by a strong padlock. One key is kept in the office, a second at the other end of the trip. Its 16 inside pockets can hold $100,000.

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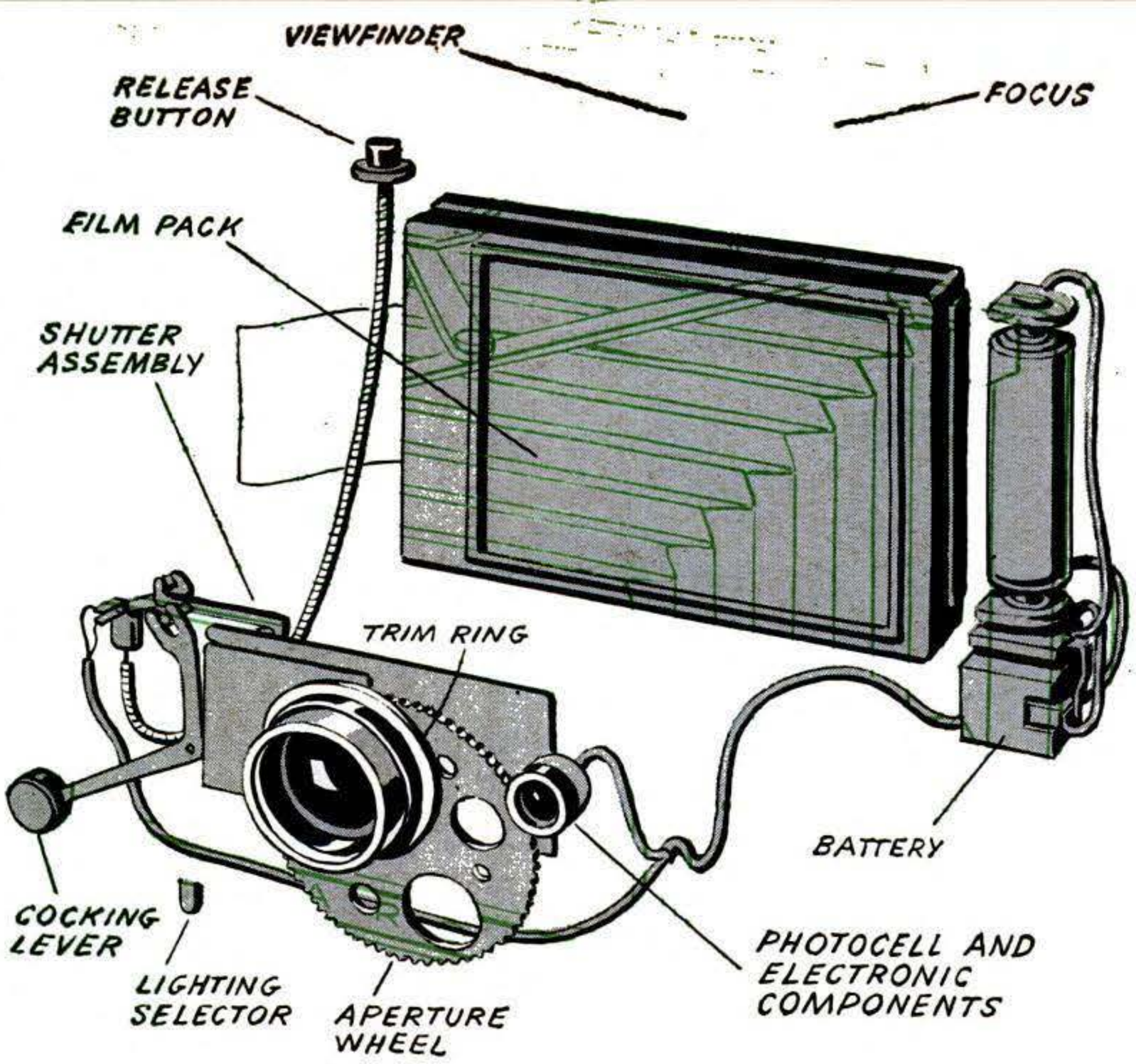
Polaroid Automatic 100 is a completely new camera weighing only 2½ pounds. Even the plastic case is part of the camera—the cover has a magnet latch. Flip it open, release a catch, and the bellows pops out.



PS PHOTOGRAPHY

Out goes the roll film in

Polaroid's Can't-Miss Electronic Camera

By Bob Hering

EIGHT months ago, Polaroid startled the world with 50-second color film [PS, Feb.]. Now they've done it again with a new camera: the Automatic 100. A new mechanism, with a transistorized electronic shutter, en-

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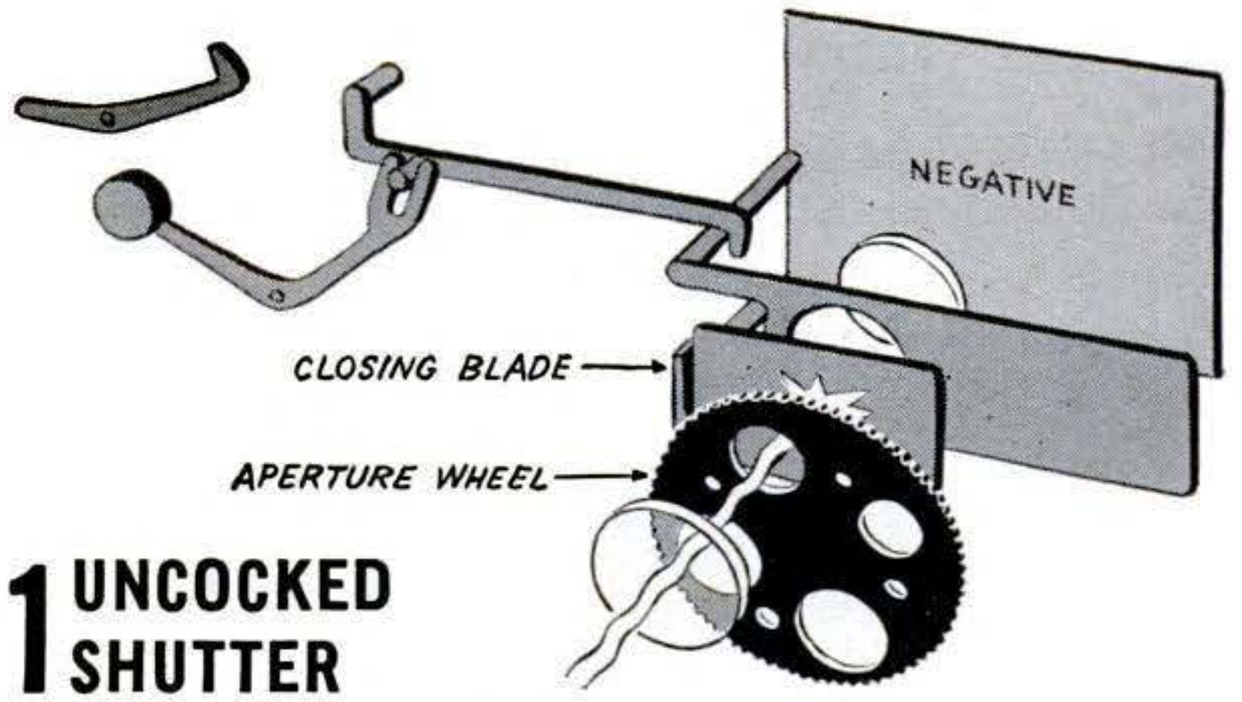
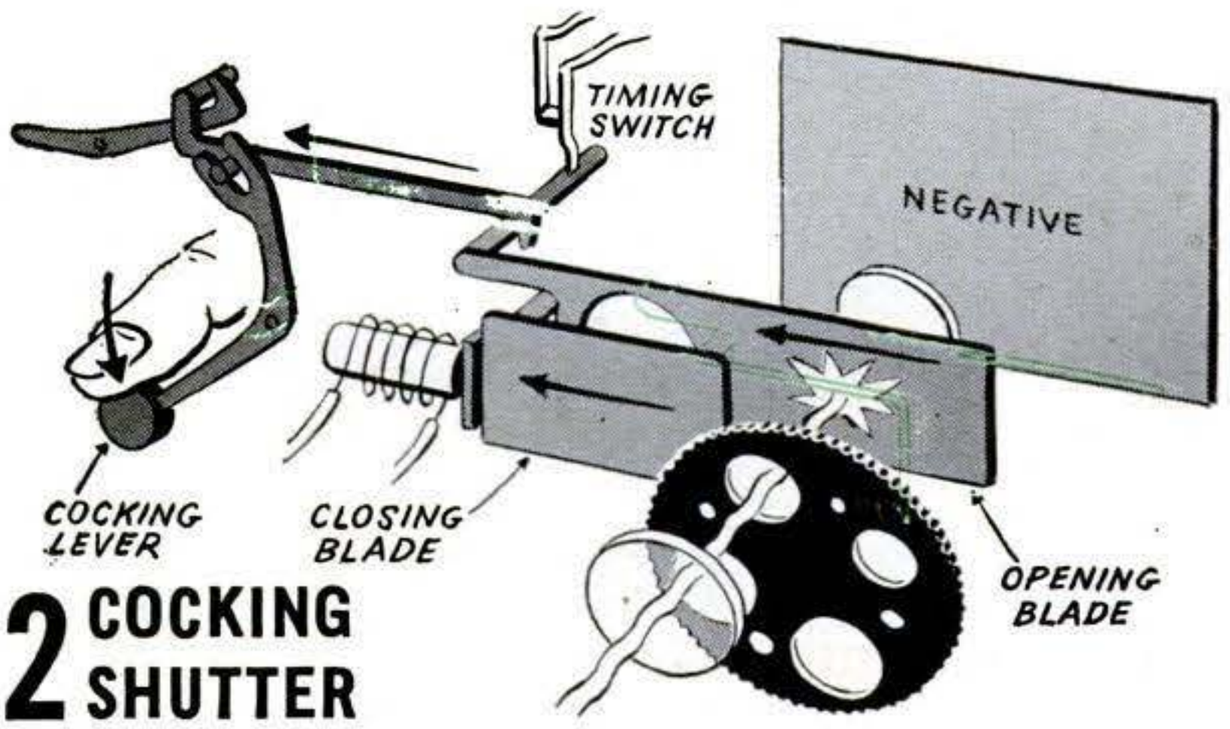


1 UNCOCKED SHUTTER

Closing blade stops light from reaching negative when shutter is uncocked. One of eight holes (*f* openings) in aperture wheel controls light to film. Each ASA setting includes two apertures. Lighting selector shifts large or small hole to operating position.



2 COCKING SHUTTER

Opening blade moves to its cocked position, carrying closing blade with it, as you press the cocking lever. Latch holds both blades against force of two springs. Opening blade now prevents light from reaching negative. Cocking the camera closes timing switch.

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3 STARTING CIRCUIT

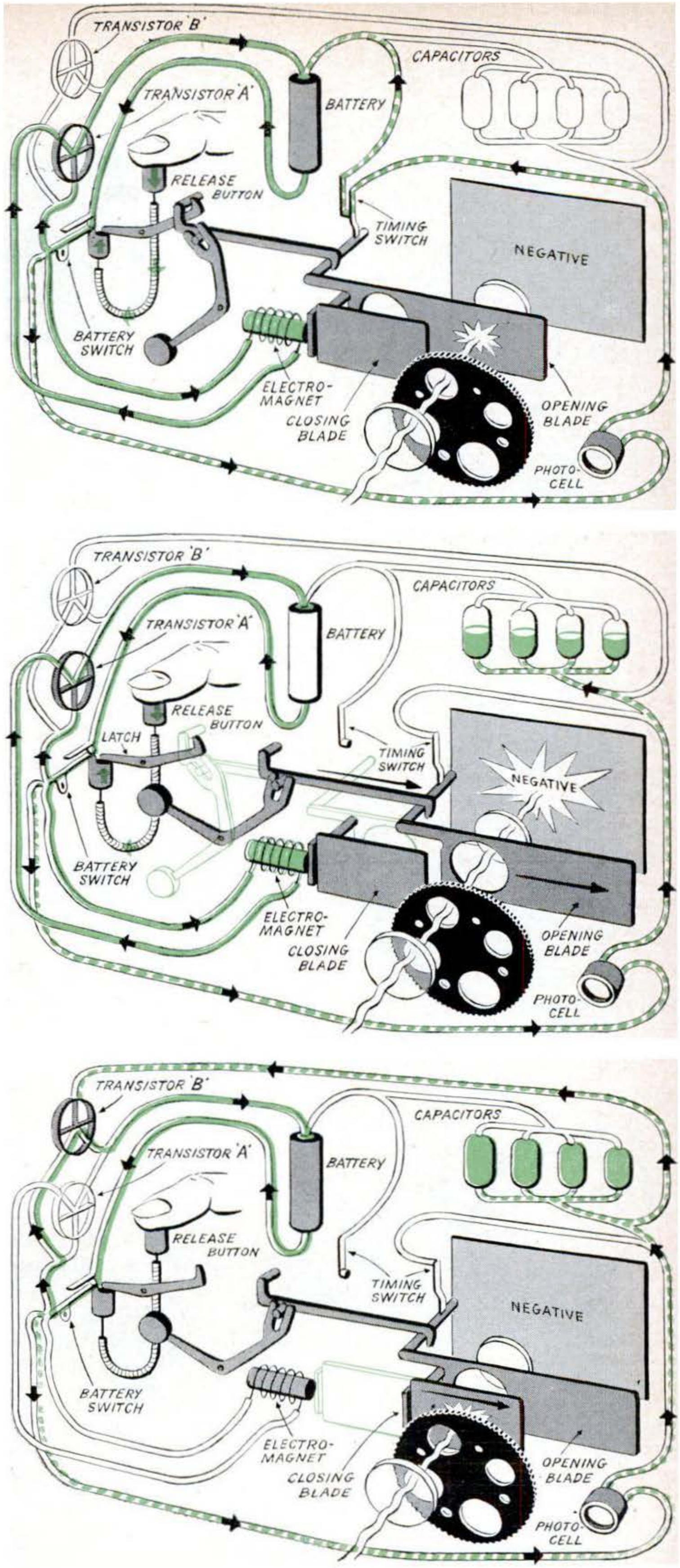
Depressing release button part way closes battery switch to complete electromagnet holding circuit (solid color wires). With insufficient current at its base, transistor A won't pass current. But with switch closed, current flows from battery through switch to base of transistor A, which allows current to pass and complete circuit between battery and electromagnet. Timing circuit (dotted color wires) energizes photocell and, following path of least resistance, bypasses capacitors and transistor B, flowing through timing switch to complete circuit.

4 OPENING SHUTTER

Depress button all the way and both shutter blades are released, but only the opening blade can move. The electromagnet, which is still energized (as above, step 3), holds back the closing blade. Light can now pass through the blade to the film. The more light reaching the photocell, the more current it will pass. With timing switch open, current flows to the capacitors, which act as storage tanks. While current is being stored in the capacitors, the electromagnet holds the closing blade.

5 CLOSING SHUTTER

When capacitors are full, current starts bypassing to base of transistor B. (Filling time varies: Bright light sends lots of current for fast fill, dim light sends less.) Once current builds up sufficiently at its base, B starts to conduct. But the only way B can get more current is to rob it from A. With its base current robbed, A stops conducting. This breaks the electromagnet holding circuit, releasing the closing blade. The blade now zips forward to close the shutter.



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ables it to do things no other camera has ever done. The circuitry handles all exposures. Electronic components replace the mechanical springs, gears, and levers of conventional shutter systems. Another shocker: The camera uses a film-pack system instead of roll film.

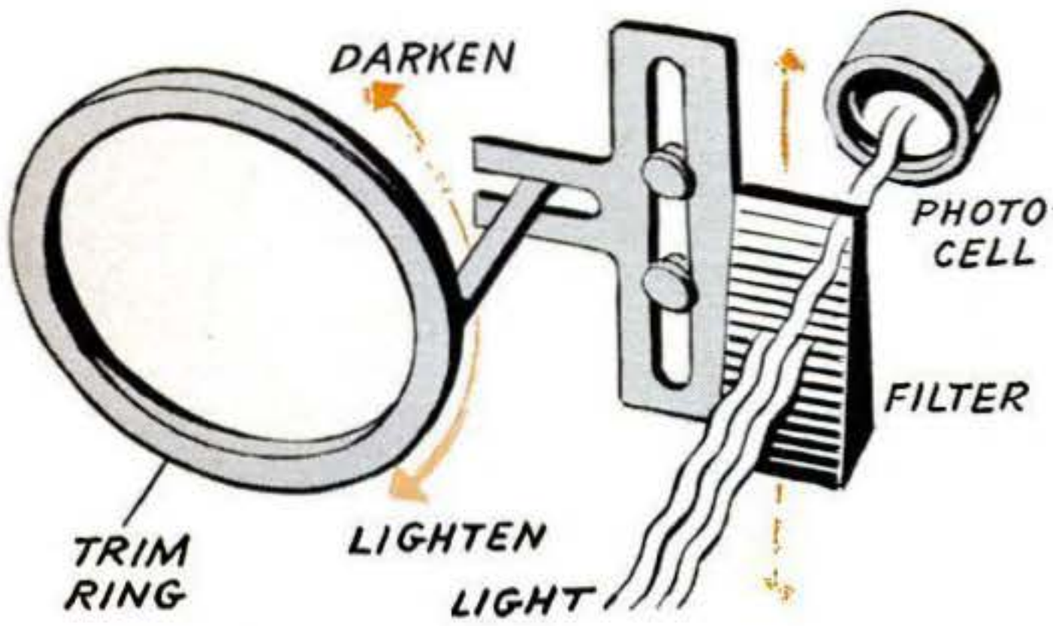
The shutter incorporates two blades, one to start the exposure, the second to end it. An electronic timing circuit reads the light entering the camera and holds the second blade until completion of the exposure.

For flash pictures, either direct or bounce, you simply focus and shoot. The electronic timing circuit calculates the light during the fractional second the flashbulb fires. Unlike other automatics, this one measures the flash lighting reflected from the walls and ceiling.

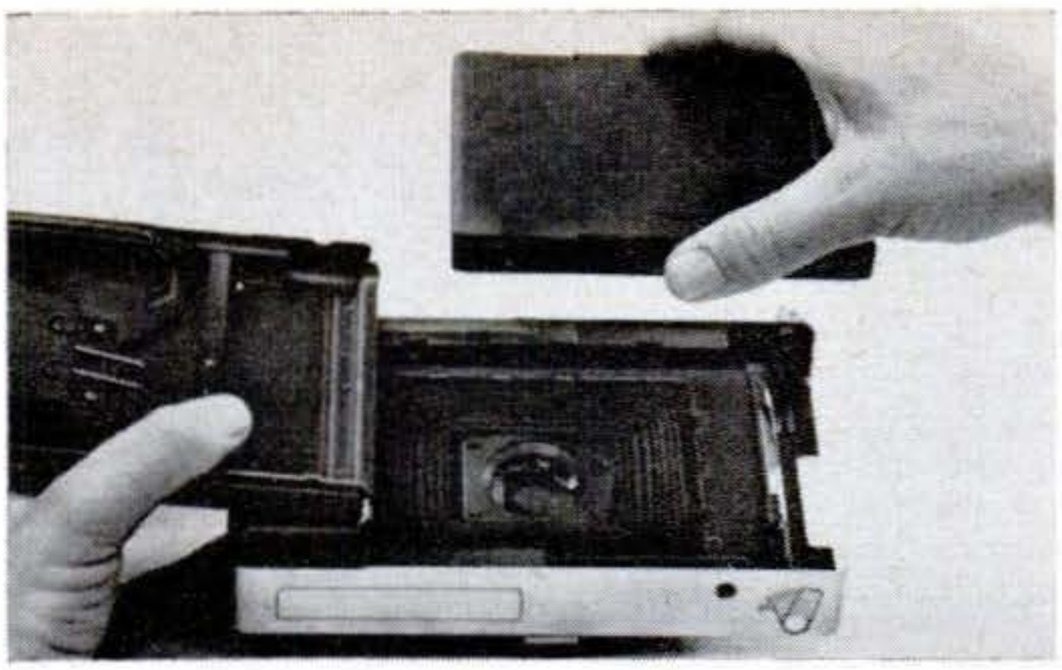
When you push the release button, the opening blade moves from behind the lens while an electromagnet grips the second blade. The electronic system starts measuring light. When the film has received enough exposure, the timing circuit signals to close the shutter and shuts off current to the magnet. The magnet releases the second blade so it can move behind the lens to end the exposure. In bright sunlight, this action can be as fast as 1/1,200 of a second.

One nifty arrangement is the way you can compensate for troublesome lighting situations. You turn a ring on the lens toward "lighten" or "darken."

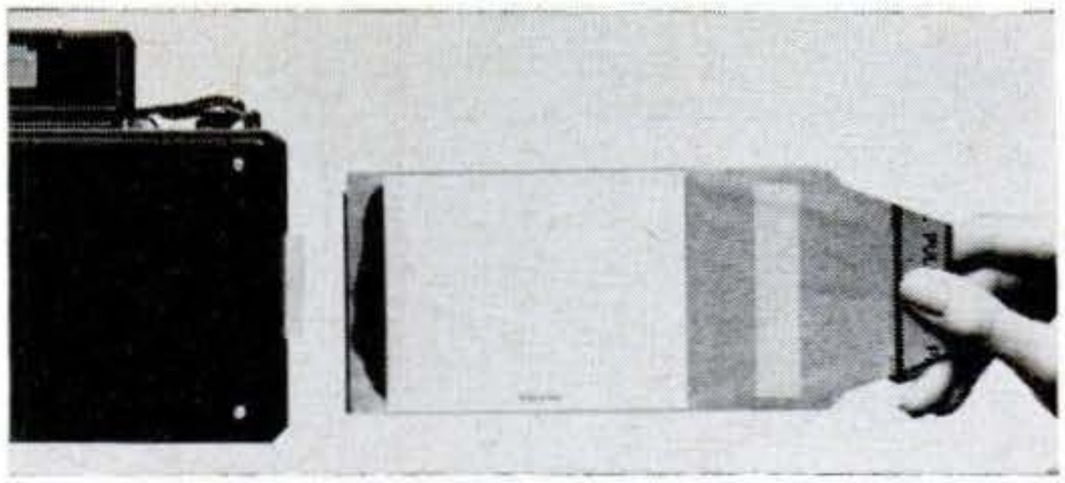
The focusing system is extremely fast. You push left or right on either end of a bar with your forefingers. When one image covers the other, you're in focus.



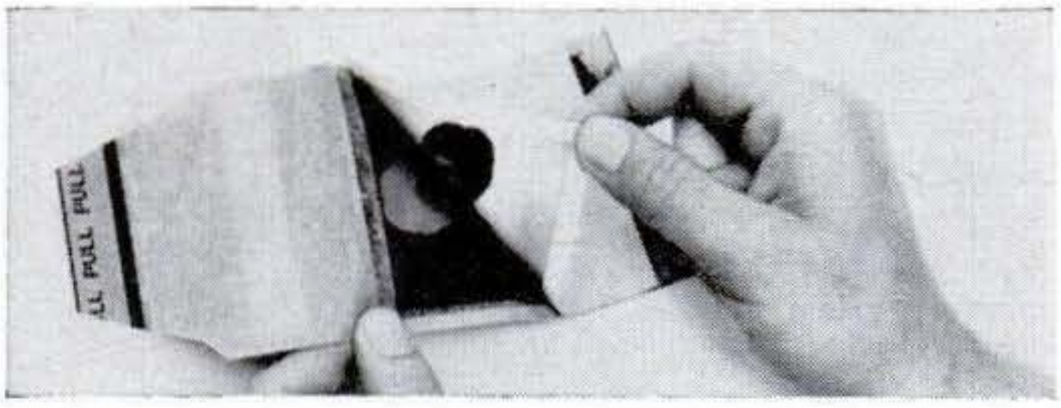
Camera's photocell can be fooled by backlighting, bright lights, or deep shadows in picture area. You can compensate for this by moving trim ring, which encircles lens, toward "lighten" or "darken" indicators. This moves wedge-shaped filter across photocell, increasing or reducing intensity of light to cell. Result: a faster or slower shutter speed than normal.



Film pack slides in easily—you'll feel it snap into position in the camera. When closing back of camera, make sure it shuts tightly.



Individual film packets can be removed from the camera and handed to someone else for processing while you continue shooting.



After developing for recommended time, you strip finished print from individual packet. Only black-and-white prints require coating.

Shifting your eye to the viewfinder, you see the scene within a white frame.

The exposure system uses M-3 flashbulbs. A blue shield is mounted on the gun. The reflector swivels neatly for bounce flash. You may prefer turning the trim ring one mark toward "lighten" for best results with bounce lighting.

For the present, two film emulsions are available: a color film, type 108 Polacolor (75 ASA) and a fast black-and-white film, type 107 (3000 ASA). Two other ASA numbers on the aperture wheel, 150 and 300, suggest new films soon. Film packs include eight 3¼"-by-4½" pictures. With the color films you get eight adhesive-surfaced mounting cards for holding pictures flat.

You should be able to buy an Automatic 100 Land camera for about $150. In highly competitive areas, prices may be lower.

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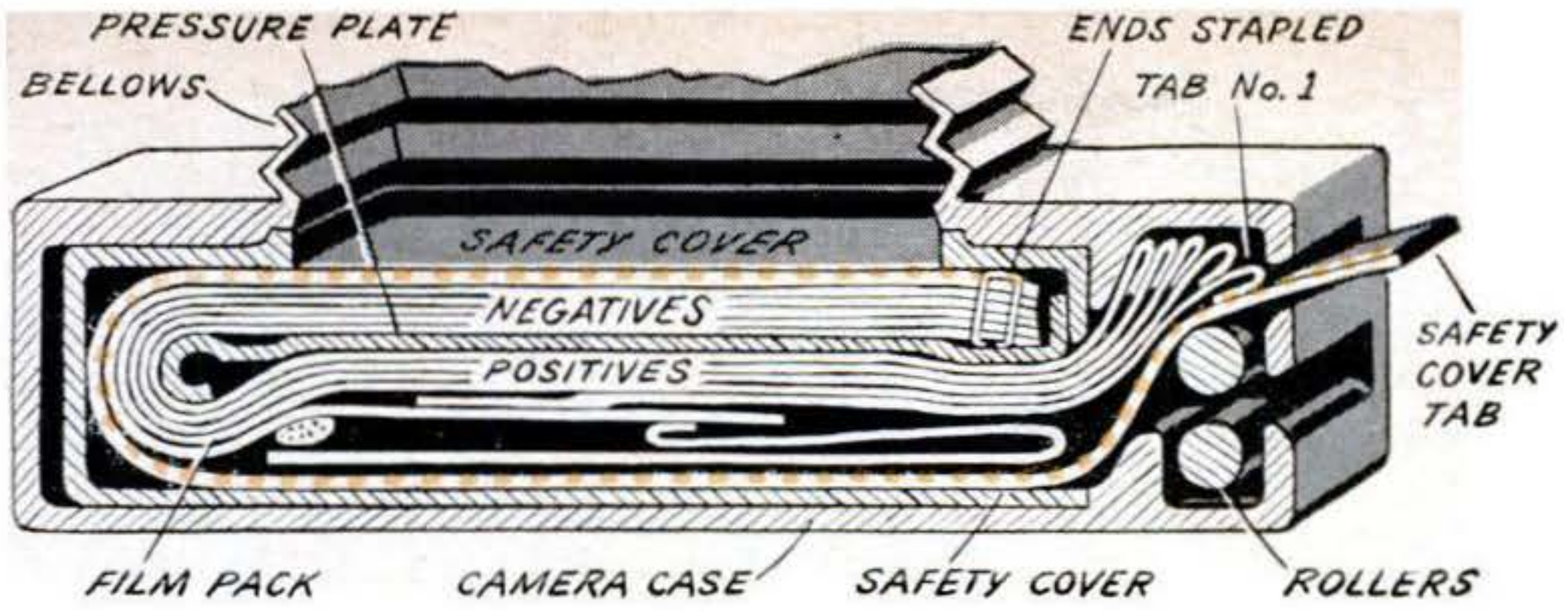
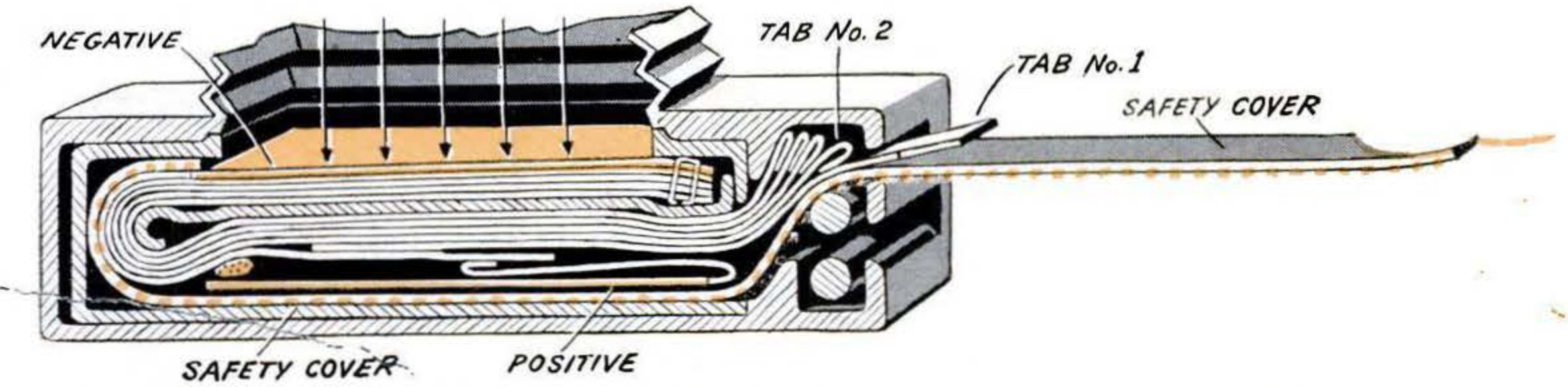
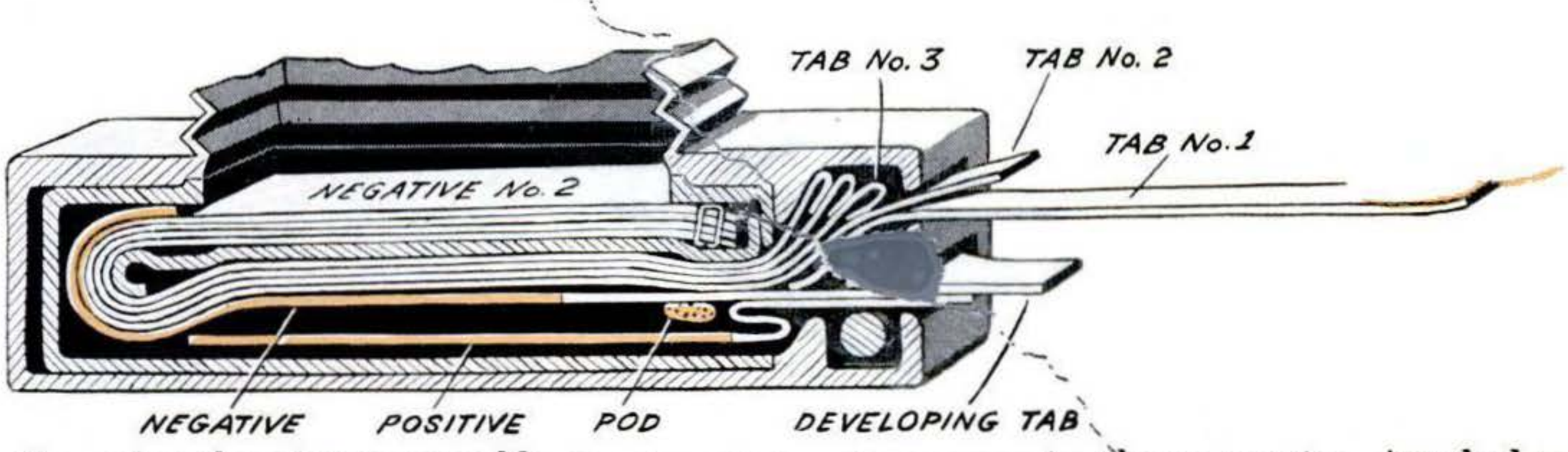
How the film pack works



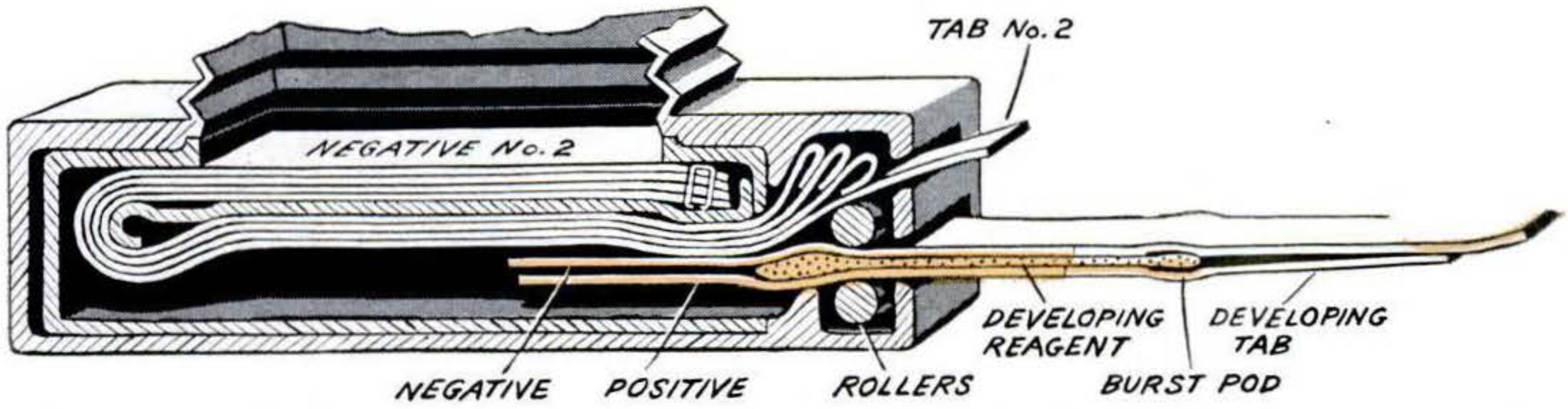
Camera back with its rollers, bellows, and film pack is shown in cutaway above. In the pack, eight separate picture assemblies (negative and positive) are folded and stacked around a steel divider in light-tight container. Staple fastens picture assemblies and safety cover to pressure plate to prevent pulling off more than one picture at a time.



When the safety-cover is drawn out through the camera slot, tab No. 1, laminated to the safety cover, unfolds until it extends out of the camera. (The tab for each picture is laminated to its successor.) You can now withdraw the safety cover and discard it. The first film is now ready to use. After shooting you can begin processing.



Removing the picture assembly is a two-stage job: First, pulling tab No. 1 brings the negative around the pressure plate to face the positive. More important, this movement also pulls the developing tab through the pressure rollers to prepare for the next action. Attached to the developing tab is a foil pod containing the developing reagent. At the same time, tab No. 2 unfolds and emerges from the camera, preparing it for the next picture sequence.



When you pull the developing tab, negative and positive pass between rollers, breaking the pod's seal and spreading jellied developing reagent between positive and negative to start processing. Picture packet is removed from the camera. Opaque backings on negative and positive prevent light from fogging the film. Springs move pressure plate and remaining negatives toward focal plane of the camera. This places a new film "in focus" for the next exposure. ■ ■

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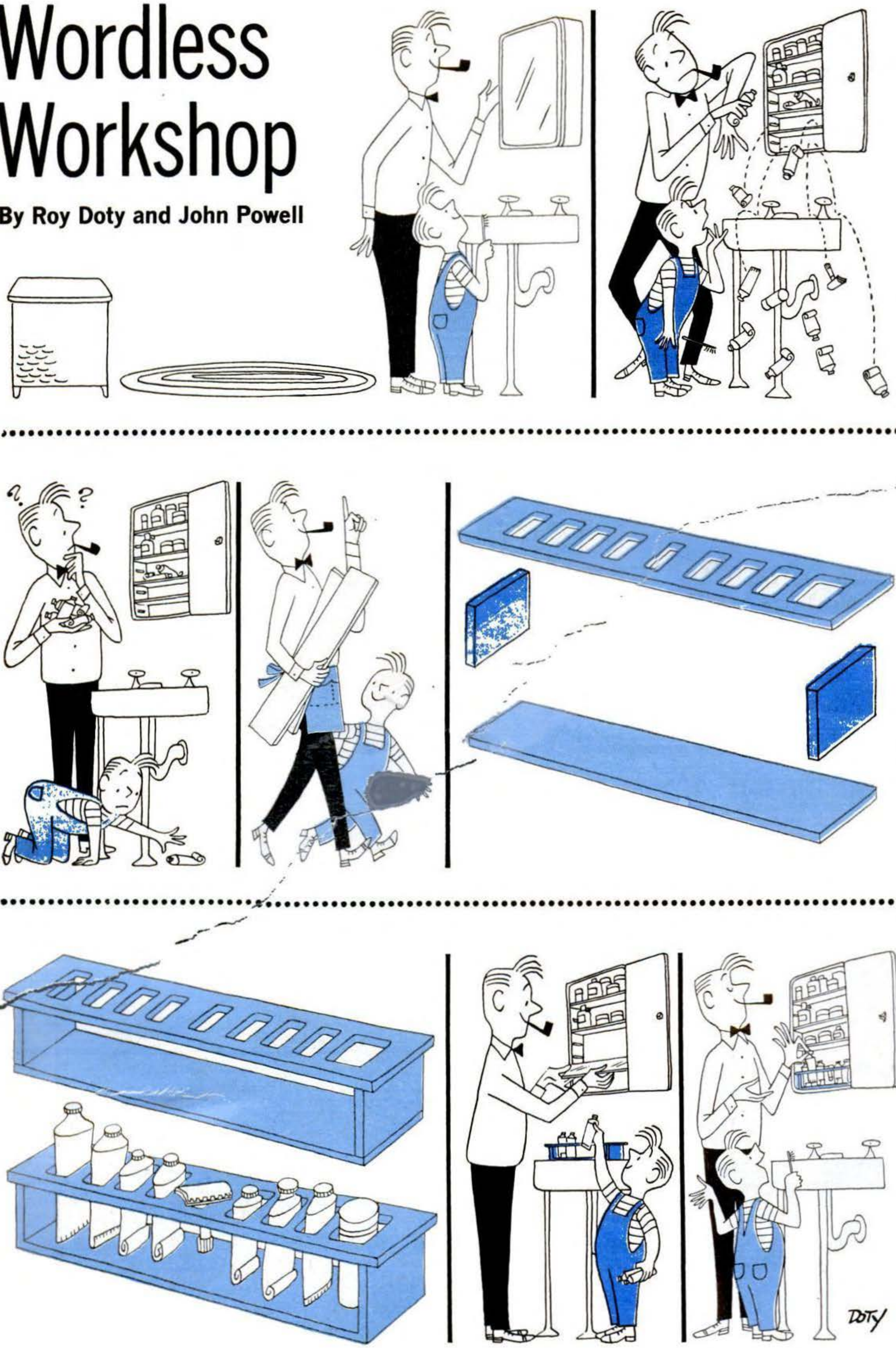
Wordless Workshop

By Roy Doty and John Powell



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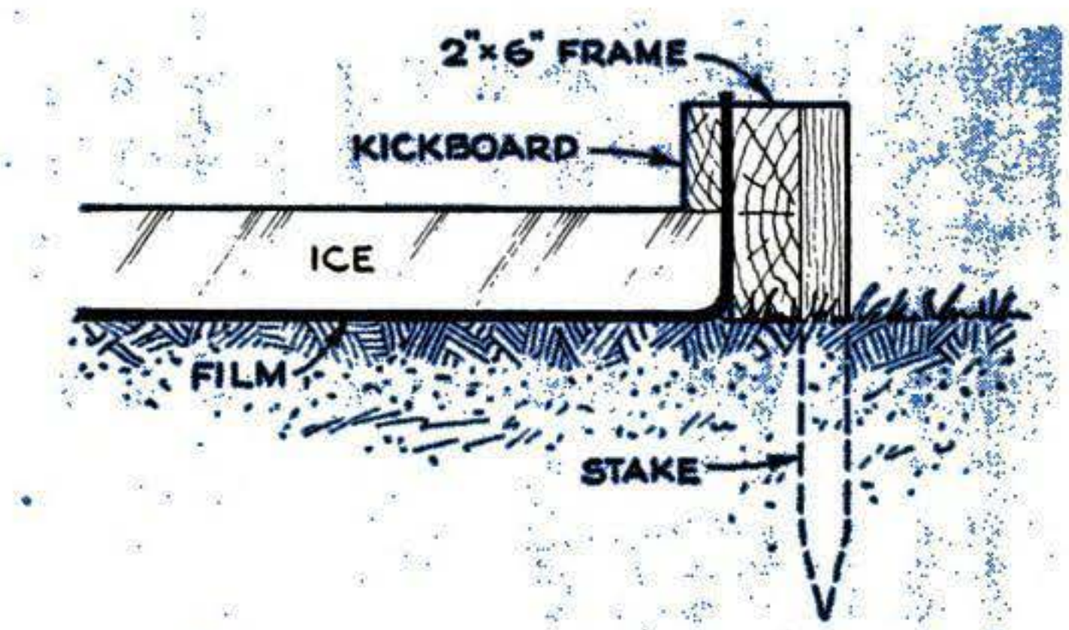
Build Your Own Skating Rink

A THIN sheet of plastic can turn your back yard into a private skating rink this winter. All it needs is a frame of boards, staked to the ground, to form it into a shallow pool. About 2″ of water is plenty for a solid ice base.

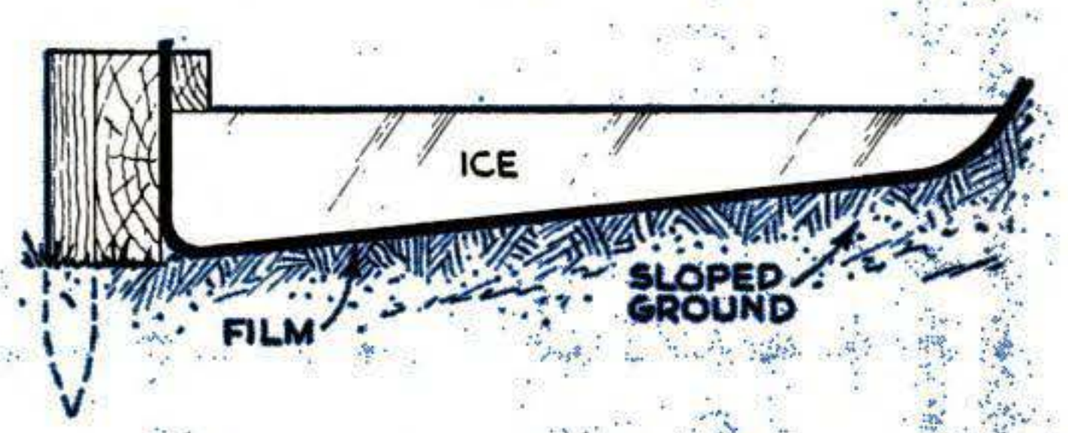
Use four-mil-thick polyethylene film for the liner (Union Carbide's VisQueen was used for the rink shown above). Be sure to buy the translucent white type; the black type may harm your grass. The film is available in sizes up to 40′ by 100′. A good-sized rink can be made with a 20′-by-40′ piece costing less than $20.

Try to locate the rink on level ground. If the ground slopes, build the frame up higher on the low side so it's level all around. The trick in getting a good joint between the frame and the plastic is to run the film up the sides and under a kickboard nailed on top, as shown in the drawing.

Store the film in a dark place after each season's use. Repair any tears with pressure-sensitive plastic tape. The film should last at least three seasons.



Level rink is best. Be sure to lap the liner up the sides of the frame, as shown.



On sloping ground, a rink needs extra frame stakes to beef up the deep end.

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Sprint zooms up the steepest hill I could find—with no fuss.

Handlebars curve upward and back, so I ride sitting up straight.

Even when leaping over rough ground, the seat is comfortable.

Here I have slowed down from high speed to 10 m.p.h. in seconds.

Made in Italy, marketed in the U.S., it's ready for the road

PS Tests H-D's Spirited New Sprint

By Erik H. Arctander

TAKE a ride with me on the spirited new Sprint—Harley-Davidson's first medium-size motorcycle. The engine's single cylinder is warmed up, so we flip the jiffy stand out of the way and shift into first. As we let out the clutch and snap open the twist-grip throttle she takes off in a rush, with no hint of clutch-slip or lurch.

Winding up in first, the speedometer needle quickly flicks over to 35 m.p.h. before the valves begin to clatter. We shift into second gear and the needle resumes its climb, reaching 55 this time. Another fast shift, into third, carries the needle to 70. And in fourth gear the speedo registers 75. This competition-model Sprint H has a modest 700 miles on its clock. According to Sprint owners, the machine is capable of 85 m.p.h. or better when fully run in. That's an impressive top speed for a single-cylinder power plant of only 15 cubic inches.

On our way to a remote stretch of road for acceleration tests we discover other impressive Sprint features. The ride, for example, is unusually comfortable. Handlebars curve upward and back, American style, so that we sit nearly erect; they're even mounted in rubber to intercept engine vibrations and road shocks. The dual seat is wide enough to support a broad bottom; it's soft without being billowy. Hinged footrests that fold up if the bike is heeled far over are upholstered in rubber.

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Splashing through a stream doesn't faze Sprint H. Competition model is especially waterproofed; it can run with the engine completely submerged.

Now we're whipping along a winding, two-lane macadam road at 60. A sharp right-hand bend posted at 30 m.p.h. looms up 100 feet ahead. We twist the throttle closed and give both powerful, seven-inch-diameter brakes a dab; in seconds they rub off 10 m.p.h. Then we drop down into third gear, lean moderately to the

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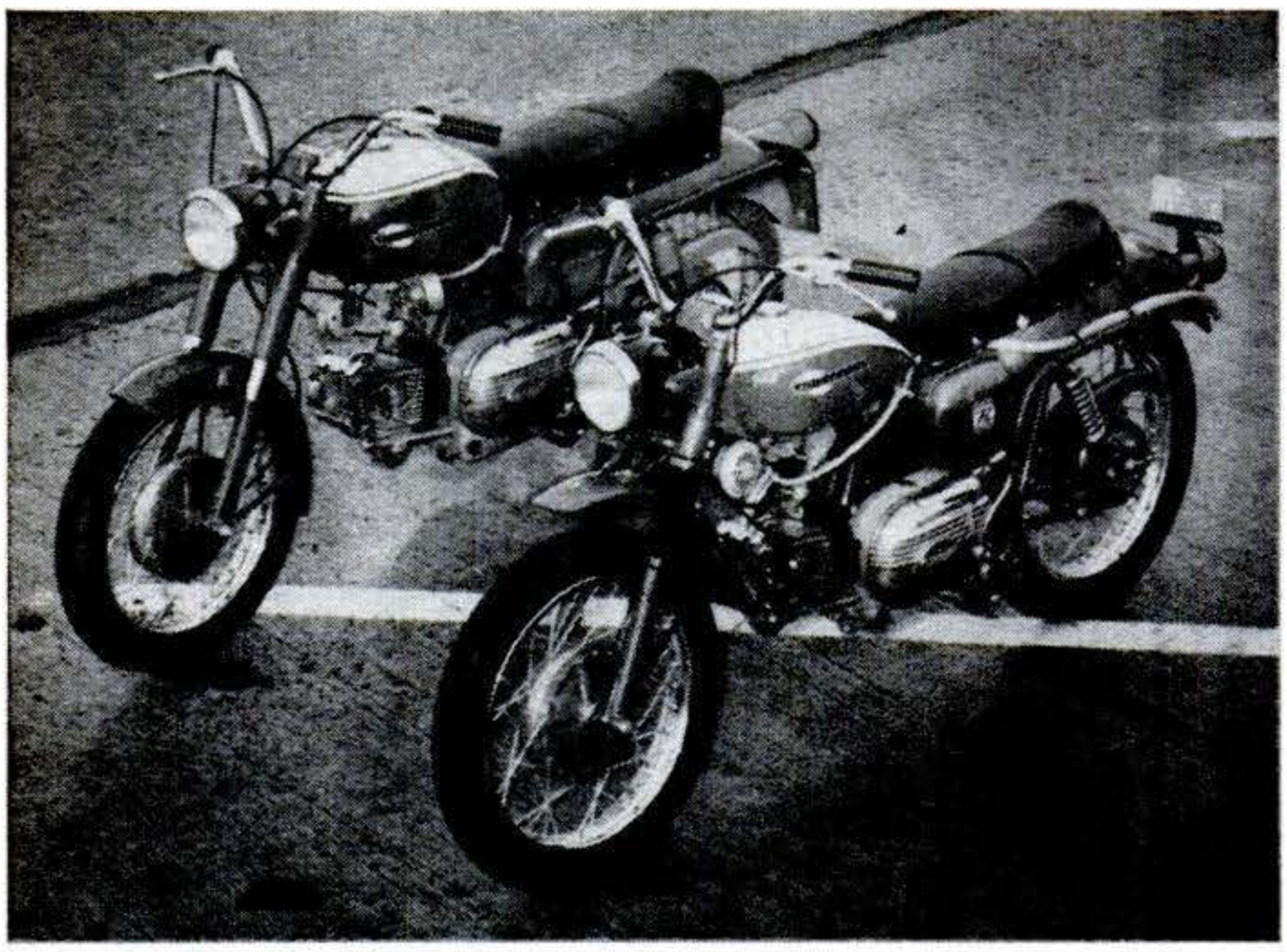
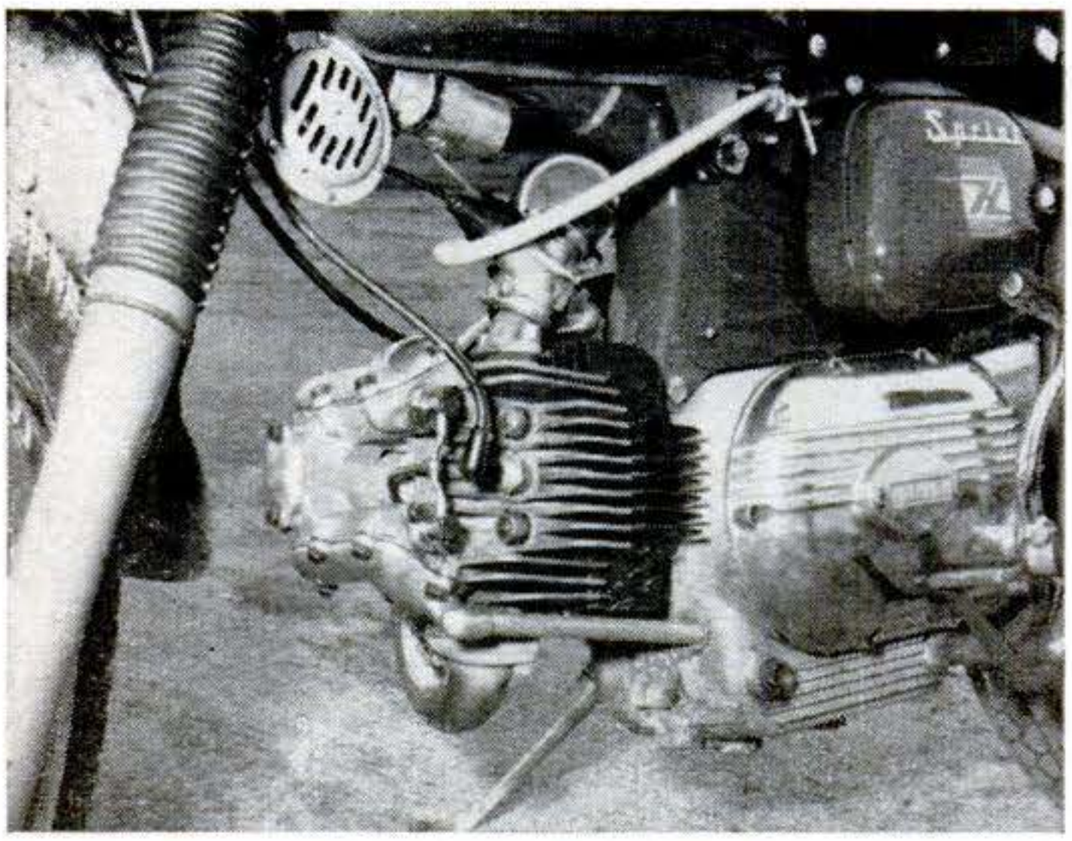
Competition bike uses paper filter in air intake, has high-level exhaust pipe; crankcase breather tube of plastic is visible just below stop light. Note large, full-width brakes.



Two Sprint models have basically similar engines and frames. Competition machine (one in foreground) has raised front fender, small gas tank, exposed rear shock absorbers.



Compact engine hangs from backbone frame, has horizontal cylinder head. Downdraft carburetor sits atop head. Also visible: horn, spark coil, plastic gas line, toolbox, kick-start lever.

right, and sweep around the bend at 40. The combination of light weight, low center of gravity, and narrow-tread tires makes cornering effortless.

Now we've arrived at our makeshift drag strip, a half-mile stretch of concrete highway that's arrow straight and dead level. With a friend timing us from alongside the road, we begin the first 0-to-60 run.

Standing still, engine revving, we drop the clutch in first gear. The Sprint shoots forward, momentarily pulling out from under us so that we slide back on the seat. At 20 m.p.h. we shift into second; again the torque, surprisingly high for this size engine, slides us backward. We tweak the clutch lever lightly once more at 40 m.p.h. and shift into third so quickly that engine revs barely drop in the process. The Sprint continues to step out briskly until it hits 55 m.p.h., then the motor bike accelerates more slowly to 60.

Six of these runs produce a cluster of 0-to-60 times of around 10 seconds. This is good, but a terminal speed within reach of that potent second gear would tell a truer story. So we try some 0-to-60 runs in first and second gears only and get an impressive 4.5-second average. So much for that trial-run job.

On the way home there is time to notice some other Sprint features. The kick-starter pedal, for example, is spring-loaded so that it folds in out of the way after each kick. There is an ignition key and a fork lock to protect against theft. A generator warning light glows red if the ignition is on but the generator is not charging. A steering damper lets you vary the resistance to turning the handlebars; it's a refinement usually found only on big bikes. Horn button and headlight switch are combined in a unit next to the left handlebar grip.

[*Continued on page 196*]

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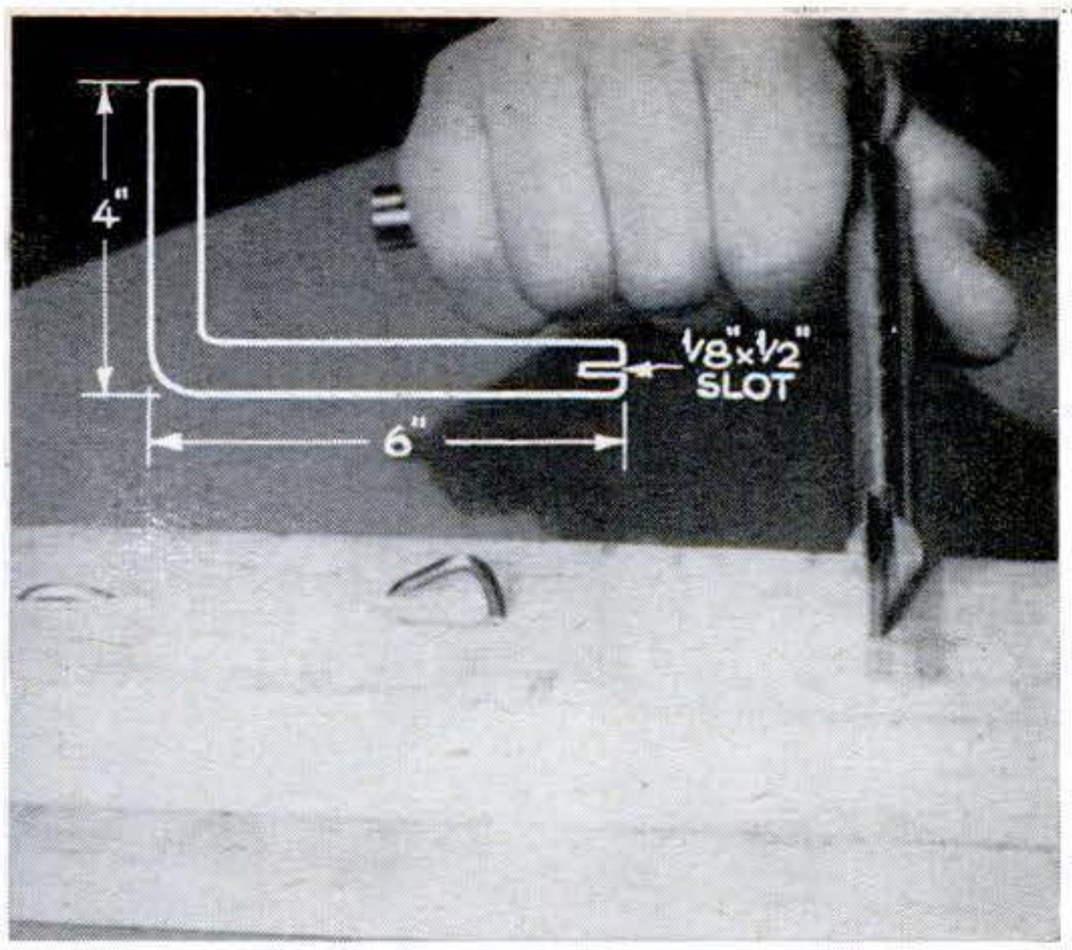
Short Cuts and Tips | FROM PS READERS



L-shaped tool clinches nails fast

Make short work of nail clinching with this handy tool—bent from ½″ cold-rolled steel or drill rod. Cut an end slot ⅛″ wide, ½″ deep, perpendicular to the plane of the L. Slip the slot over a nail (about midpoint of protrusion), give the nail a quick twist, and finish off with a hammer.—*Robert Micals, Freehold, N.J.*

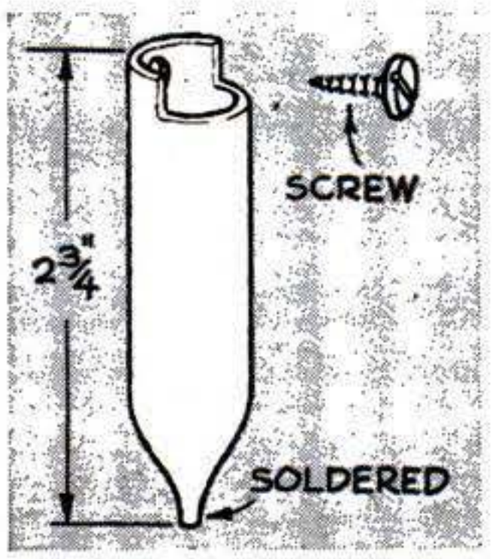
Spacing fabric tacks evenly

Decorative tacks for furniture are on display, and should be evenly spaced. Do it by marking a strip of paper and taping it over the work. Start tacks through the paper (right), then tear it out and finish nailing.—*William Swallow, Brooklyn, N.Y.*

►►►Here's how to avoid getting lamp-reflector burns on your forehead when you stoop for a closer look at your work—say, on a lathe chuck. Bend 1″ chicken wire around the reflector so that it stands away from the metal about ¾″. Secure it by crimping the cut wire ends around the reflector edges.—*John A. Blaker, Auburn, Mass.*

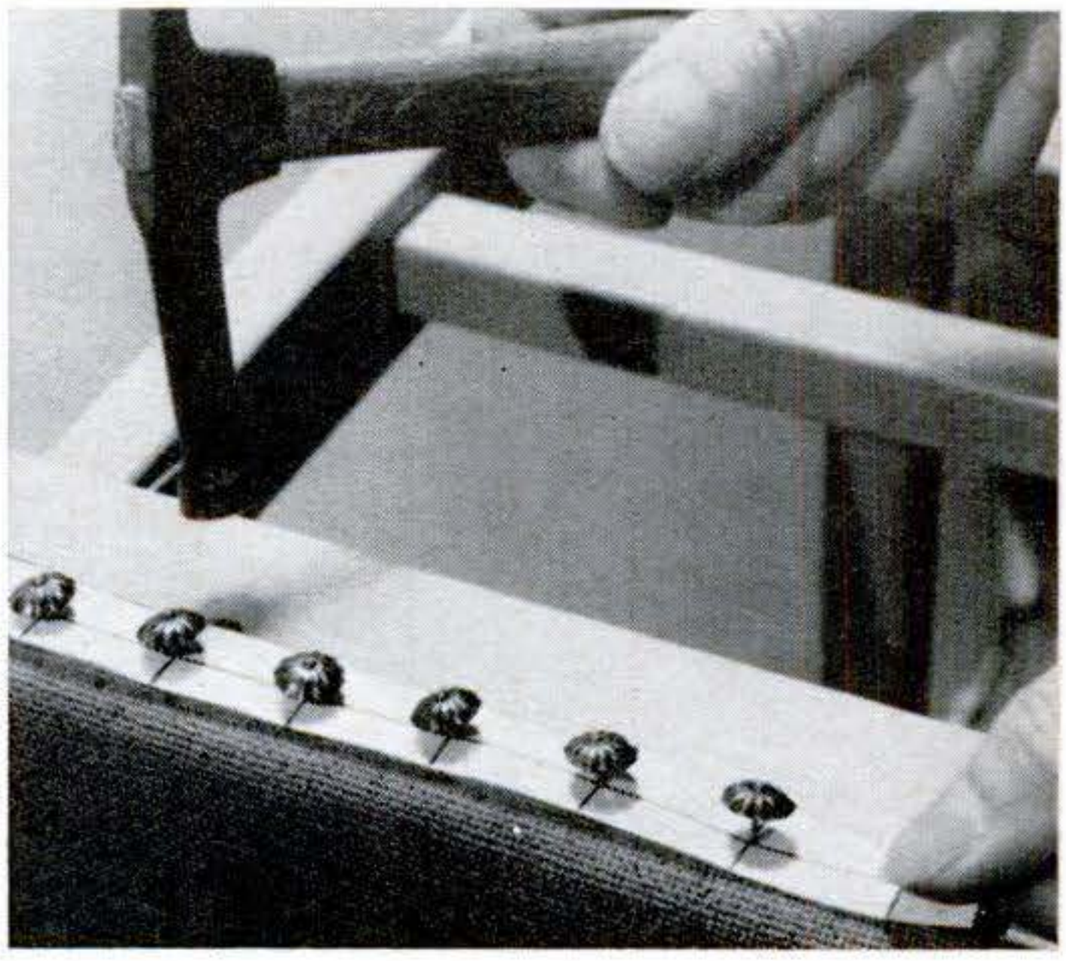
Oil dip keeps drill bits rustfree

This easy-to-make oil dip will keep drill bits free of rust in moist basement air. It's cut from ¾″ copper tubing, heat-sealed at one end, and attached to the wall near the bit holder. The idea is to dip the bit top in oil after use, drop it in the holder and let dripping oil coat the working end.—*George E. Sparks, Chillicothe, Ohio.*



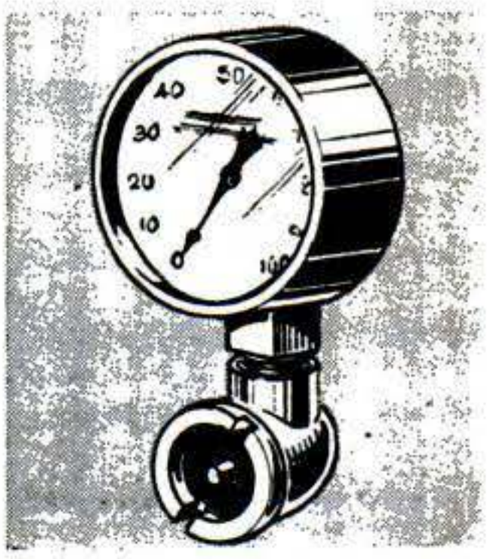
Angled muffin tin stores small parts

An old muffin tin mounted at an angle makes hardware selection easy. Draw a 30-degree right triangle with the tin's width the hypotenuse. Cut a piece of sheet metal the length of the tin and the width of the combined triangle legs. Bend the metal at a 90-degree angle in a vise and solder it in place.—*W. H. McClay, Pasadena, Calif.*



One gauge for all tires

Weary of the inconvenience of using separate tire gauges to check my tractor tires—a high-pressure gauge for the front, a low-pressure gauge for the rear—I fitted a tire air chuck to a 100-pound-dial air-pressure gauge. It works well, and making it was easy, since both chuck and gauge have ¼″ pipe threads.—*Paul Marshall, Alta, Iowa.*



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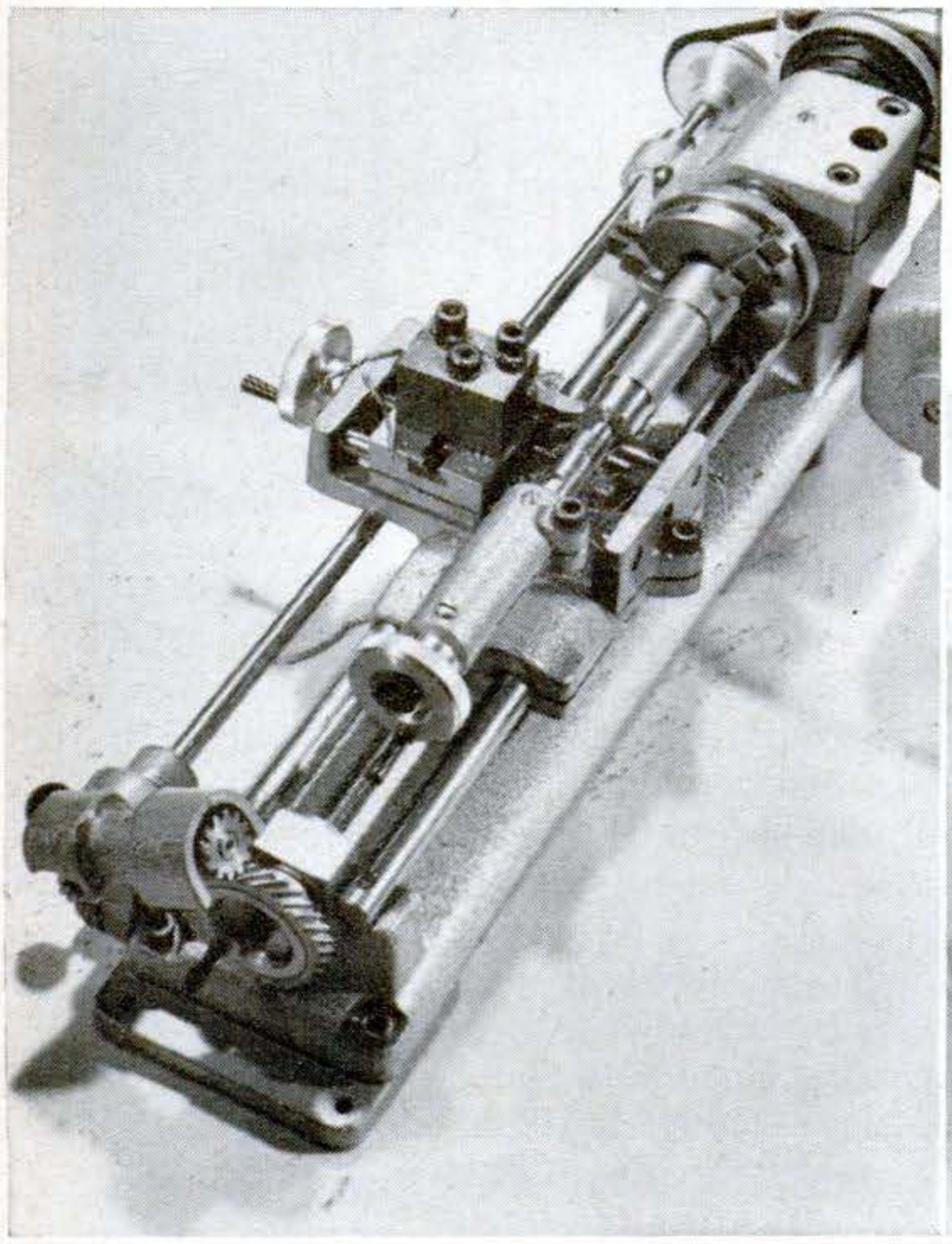
Plain and fancy turning are routine jobs for this surprising



New power feed, shown at left, is belt-driven from spindle at headstock end and turns the lead screw through bevel gears at the tailstock end. On brass, it readily turns down 3/32" at a pass, leaving an almost polish-smooth finish. For taper turning (below) you swivel the headstock instead of offsetting the tailstock. When the angle is small, you can couple up the power-feed belt for automatic taper cuts.

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A personal-use report on:

PS TOOLS

A Midget Lathe That Does Mighty Jobs

Smaller than a sewing machine, the amazing Unimat rivals big tools for ruggedness—and fun

By Harry Walton

SMALL for a lathe (you can tuck it under one arm), the Unimat is actually a drill press, horizontal and vertical milling machine, surface grinder, and gear maker all in one. Say all that about a 17"-long chunk of hardware and you get raised eyebrows from most machinists.

I was pretty skeptical myself. "Turn hard scale off an iron casting on this?" I thought. "Mill honest-to-carbon steel? Cut threads without lead-screw gears? It *can't* do all that."

It not only can, but it can even cut *multiple* threads. I found the Unimat an amazingly versatile metalworking tool. Don't let its size fool you—a .25-caliber pistol isn't big, either.

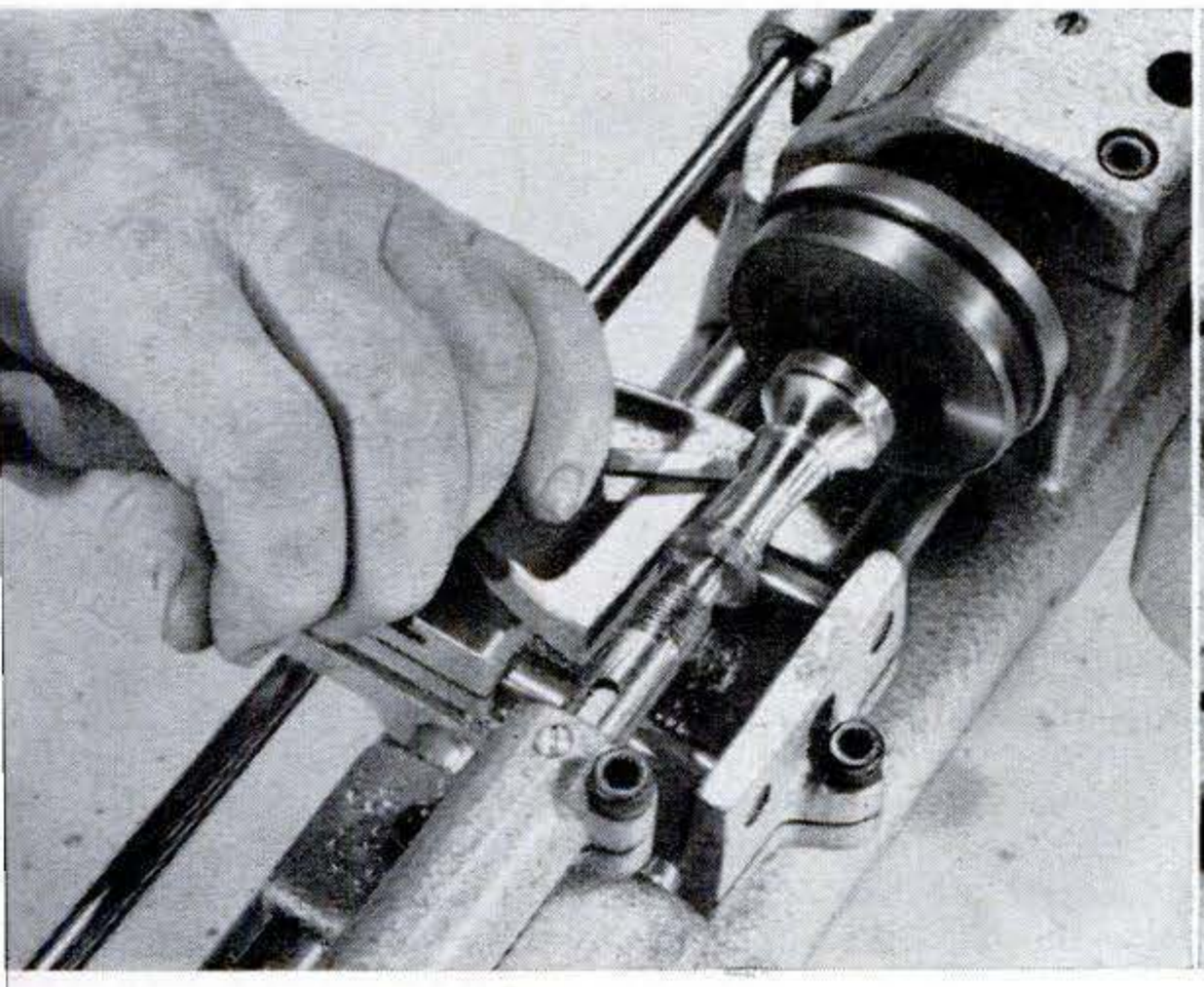
Machine shop in a box. The Unimat is roughly the size of a small sewing machine and costs about the same—around $140. At first glance, its specs aren't impressive. Inside chuck capacity is $\frac{15}{16}$"; with jaws reversed, it will swing diameters up to 2 15/64". The longest work you can mount

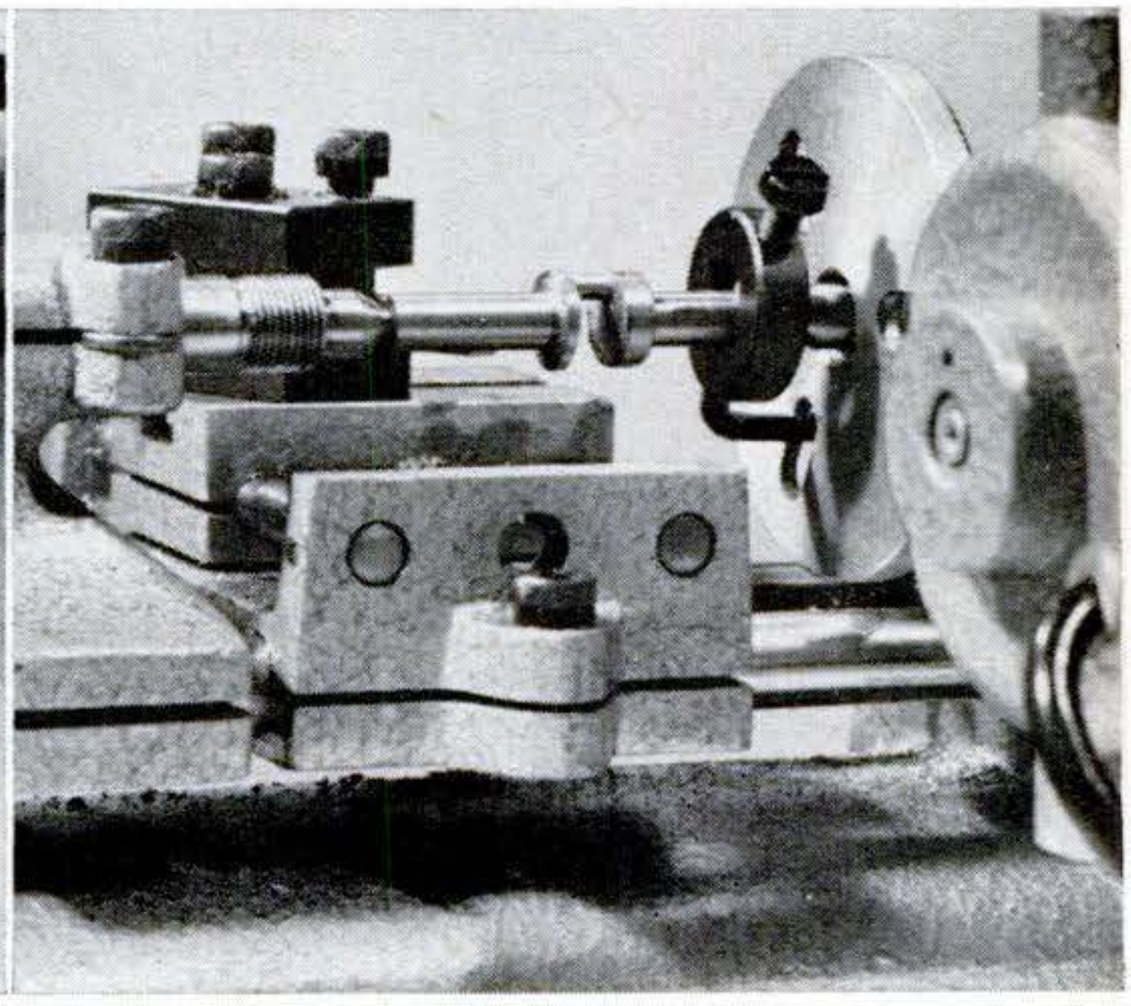
CONTINUED

little tool. And now there's a real power-feed attachment, too

Freehand turning can create intricate shapes in metal, like this brass chessman. The tool is supported on a rest bolted to the cross slide. A longer rest that bolts directly to one of the lathe ways is also available. The Unimat comes ready to use for about $140. Though the tool is basically a metal-turning lathe, an ingenious vertical column mount and detachable headstock quickly convert it to a drill press.

This one-piece crankshaft was turned as part of the PS tests. A length of steel shafting was first mounted offcenter to turn out the crankpin, a difficult interrupted cut. The space between the webs was then blocked for turning the journals to size. Attachments for the Unimat enable it to cut threads, do indexing and gear cutting, and drive an accessory jigsaw, flexible shaft, or 2½" circular saw.





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between centers is 6⅜". Stock of $\frac{7}{32}$" diameter will go through the hollow spindle, but ¼" stock is stopped at 2½".

Obviously, the Unimat isn't for truing brake drums or turning bowling pins. It's strictly for the million-and-one smaller jobs encountered by modelmakers, inventors, camera fans, telescope builders, gun buffs, lab technicians, designers, experimenters, and hobbyists.

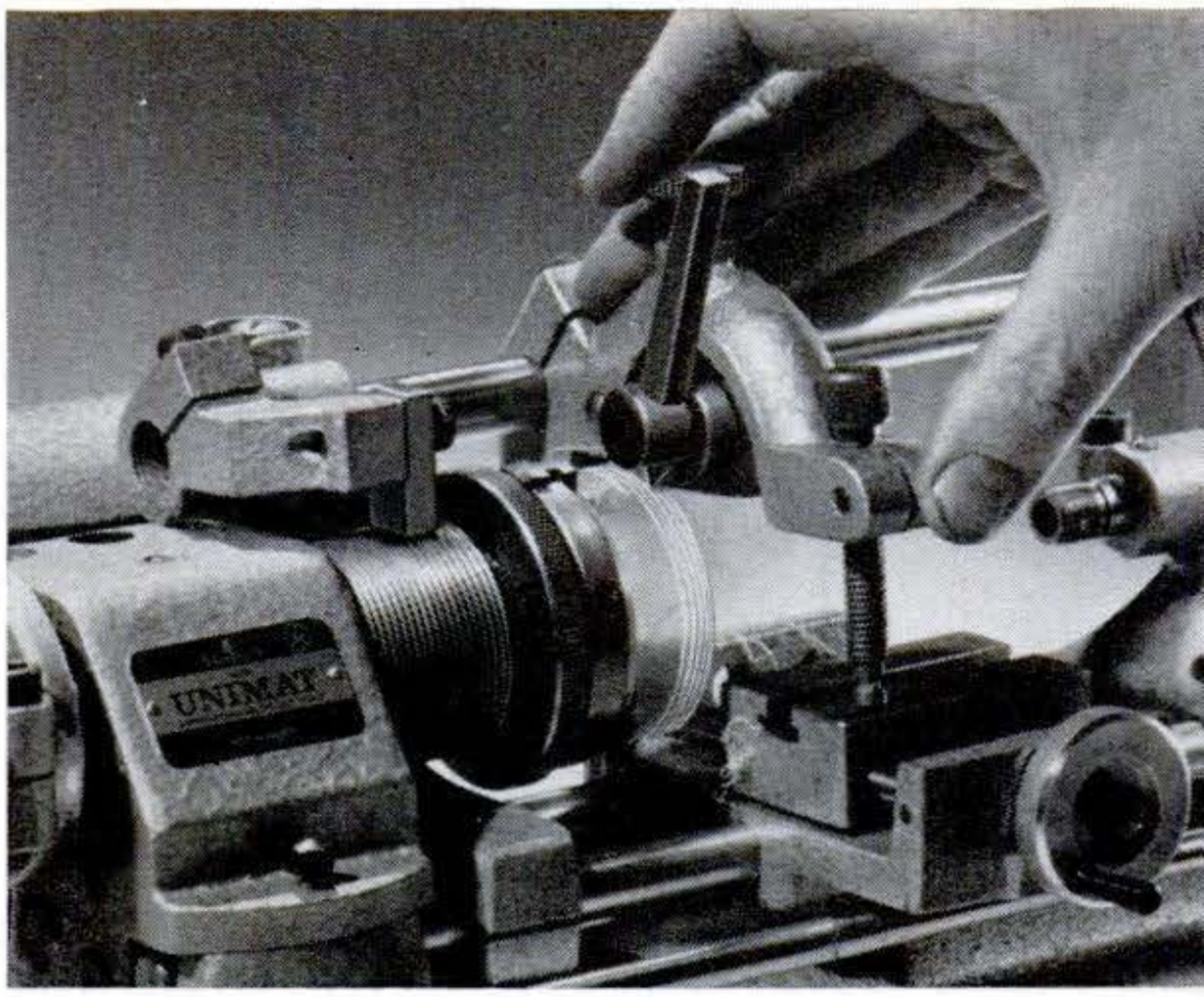
Made in Austria, the Unimat has a solid, no-nonsense feel about it. The ways are steel. One hollow-head bolt takes up play in the carriage, or locks it. Another does the same for the cross slide.

The detachable headstock can be mounted on a hefty steel column to become —presto!—a drill press. It can be swung around in a 360-degree arc and clamped with the spindle vertical or at any angle. Taper bolts draw up to lock it solidly. One size of Allen wrench fits every bolt.

Three-step pulleys on the motor, countershaft, and spindle give you a choice of 11 speeds from 900 r.p.m. to 7,200 r.p.m. A slow-speed attachment adds a fourth pulley to give speeds down to 330 r.p.m. The motor is so quiet you can use the machine while the family's asleep.

Close-quarter machining. Accustomed to a

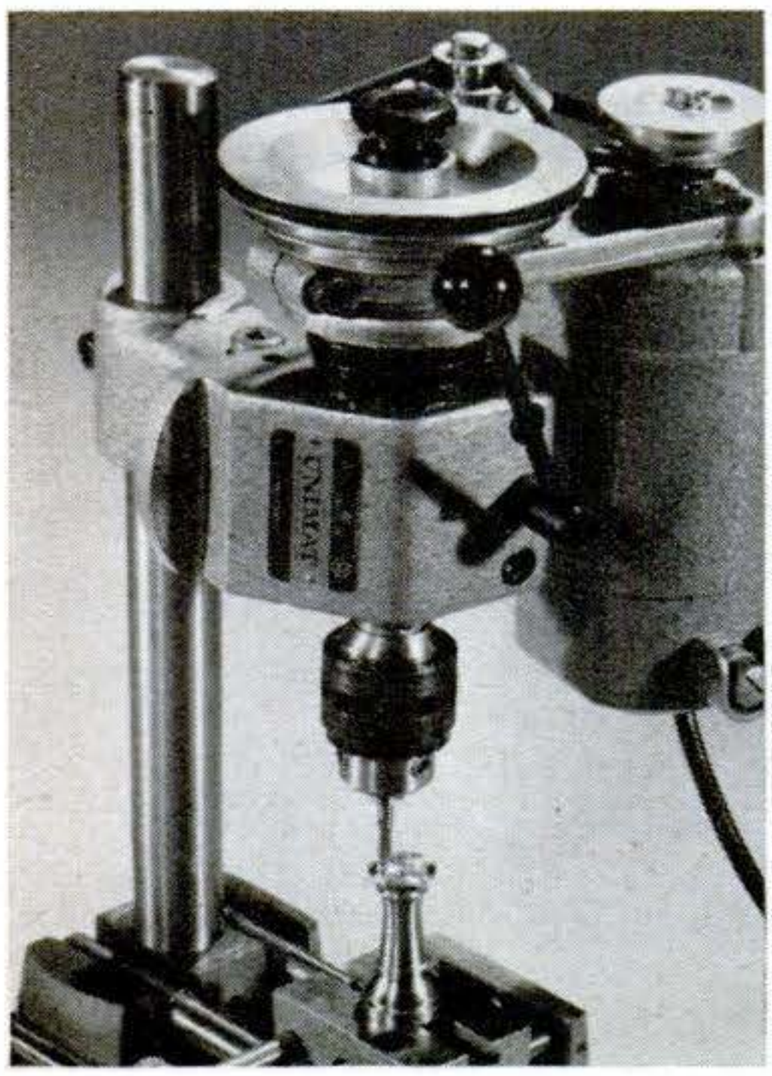
Threading, slitting, and



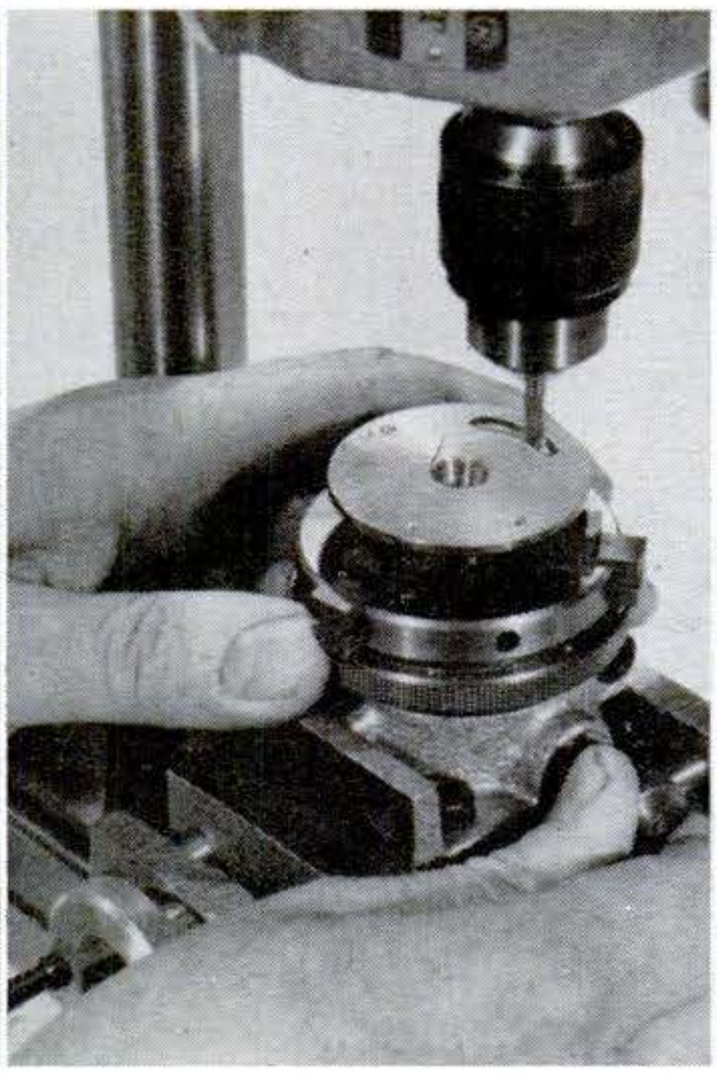
Threads are cut with a follower arm that rides a pattern. The follower pulls the tool holder behind it, duplicating the pattern's threads in the work. Tool is tilted up and returned to the start to make successive passes. Patterns come for 16 to 56 threads per inch, also in metric.

10" lathe, I skinned a few knuckles getting used to the Unimat's small clearances. But once I got the feel of it, work became downright fun. About the time it looked as if something couldn't be done, I'd dis-

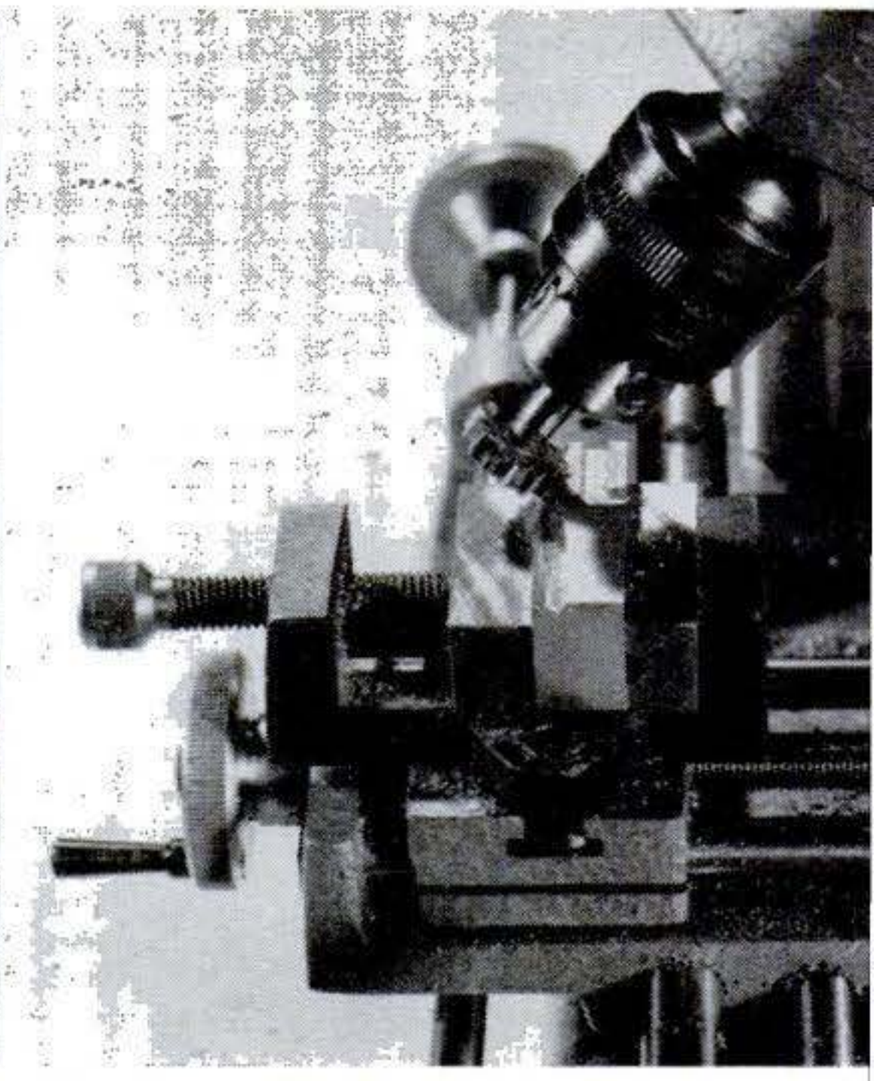
It's even a milling machine—and a surface grinder, too



Set up to mill, the Unimat makes quick work of cross-slotting this brass chess rook. With the rook mounted on the cross slide, the cross-feed is used for one slot and the longitudinal feed for the other. This makes it easy to get the slots exactly 90 degrees apart.



Milling a blind slot on an arc, an all but impossible job by any other means, is a cinch. With the chuck on the indexing attachment, two starting holes are drilled the required number of degrees apart. Then chuck is rotated by hand as an end mill is slowly lowered.



Milling at an angle is one of the many off-trail jobs you can do on the Unimat. Here the headstock is locked at a tilt on the vertical column and a ½" keyway cutter takes 1/64"-deep bites in aluminum. A shallower final pass with the cutter put a good finish on the notch.

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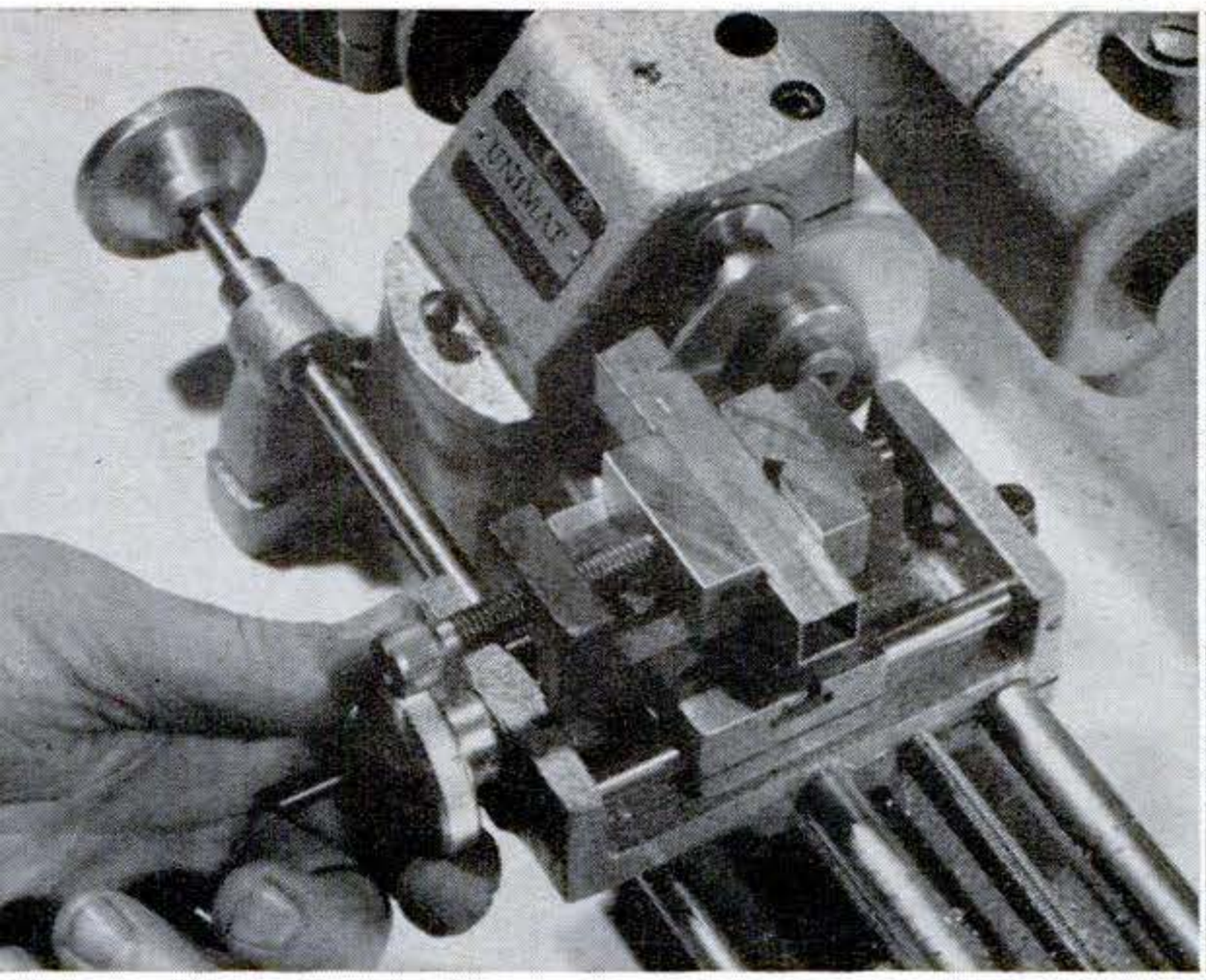
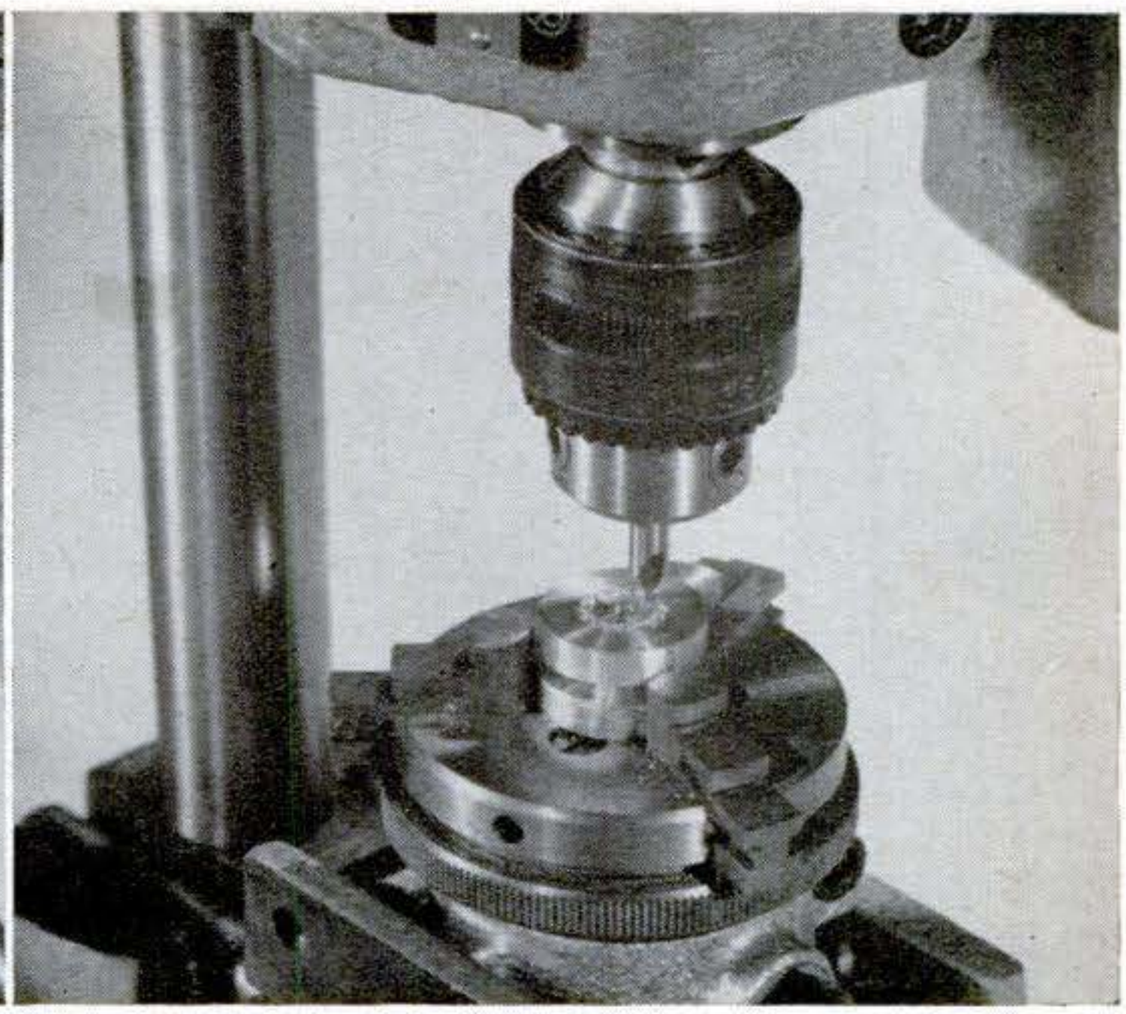
indexing give you an idea of the tiny lathe's versatility



Dead-square cutoffs are easy to make with a slitting saw on the spindle and the work in a vise. The vise shown is an accessory that mounts on the cross slide. One advantage of the small lathe: The setup takes a fifth the time it would on a standard 9″ or 10″ lathe.

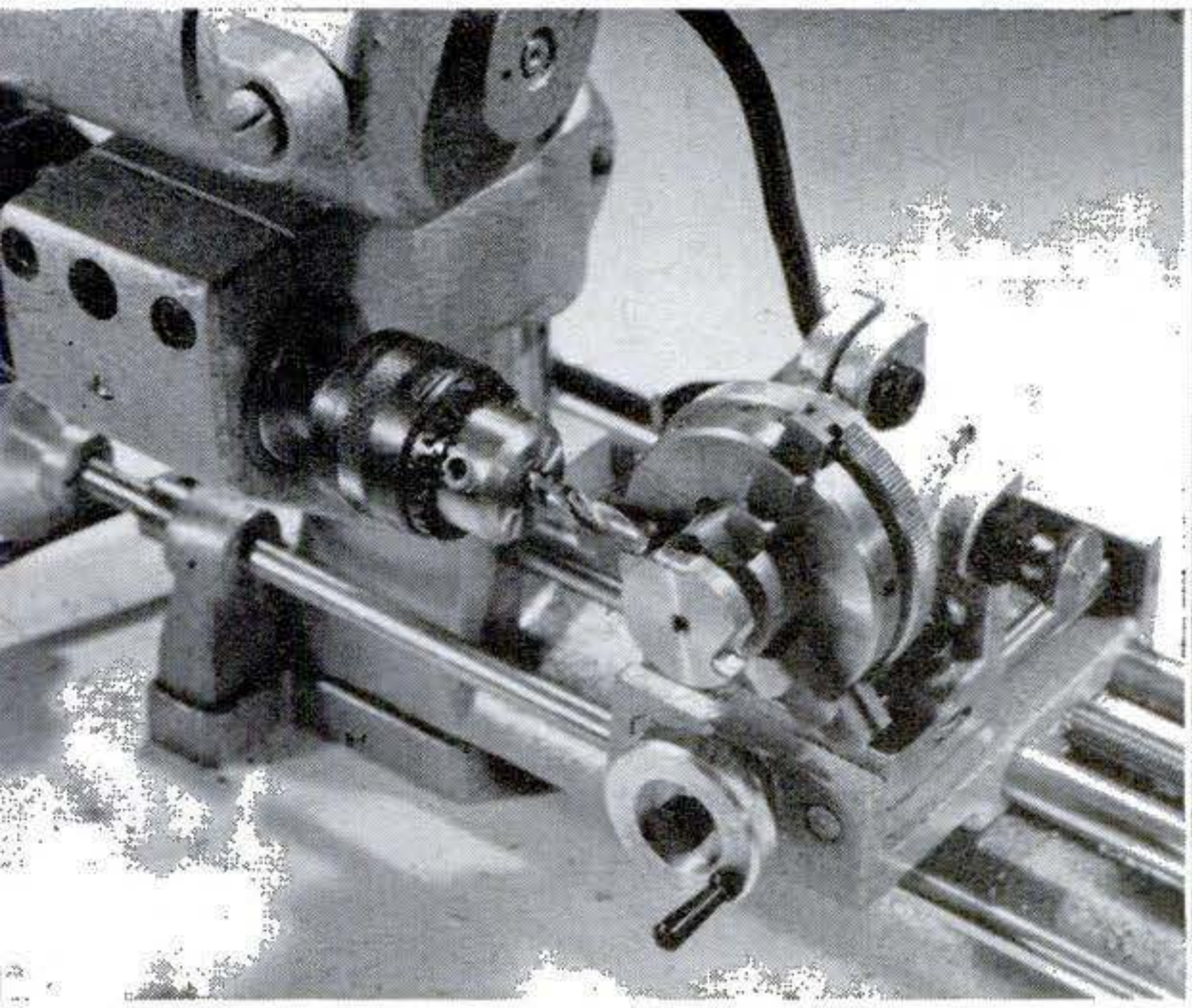


Indexing 16 holes on a blank for a miniature turbine wheel is a precision job made possible by this 48-division indexing attachment, available as an accessory. For this, the headstock is column-mounted in its drill-press position, a changeover that takes only one minute.

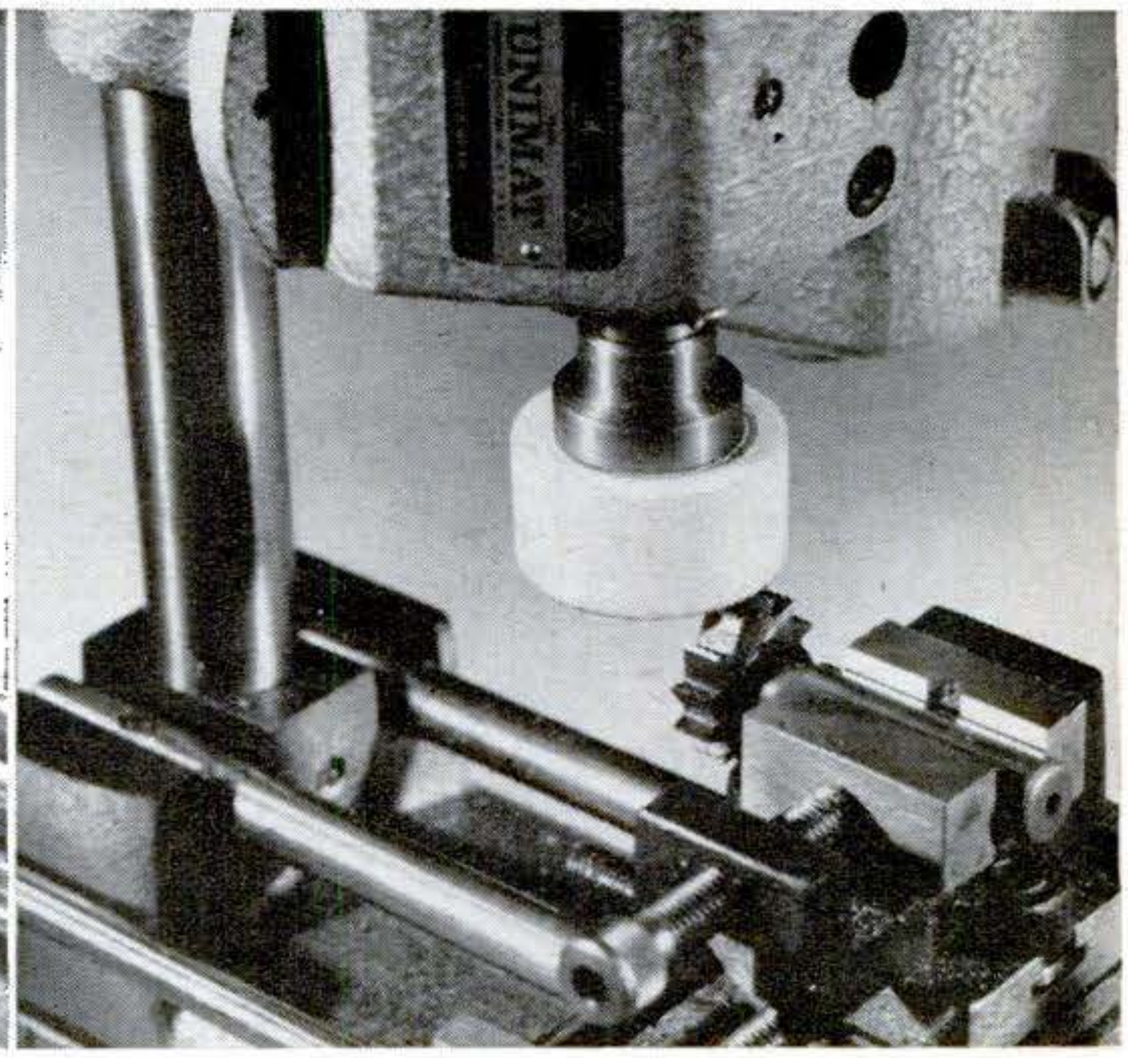
cover that the motor could be swung out of the way, the indexing attachment or milling table mounted differently, or the spindle tilted at some weird angle to make the job possible.

What I found you *can't* do is bull through a cut with dull tools or neglect a fairly constant housekeeping chore. Chips seem bigger than scale size on this little ma-

[*Continued on page 220*]



The roughest test of all: This improvised end mill made from an old drill bit slogs along in 3/16″ steel, showing a deplorable amount of overhang. It had to be nursed at a slow feed, but got the job done—a testament to Unimat's ruggedness. Note that the work, a disk being notched for balls in an over-running clutch, is mounted with the indexing attachment in a vertical position—another trick you can do.



Surface grinding, usually a job for expensive production machines, can be done by taking advantage of Unimat's column mount. Swing the cup wheel to one side and you can grind flats on work that's longer than the lathe bed. Here the wheel is set up to sharpen a milling cutter held in the vise and traversed with the longitudinal feed. (Protective ways cover has been removed to show the setup more clearly.)

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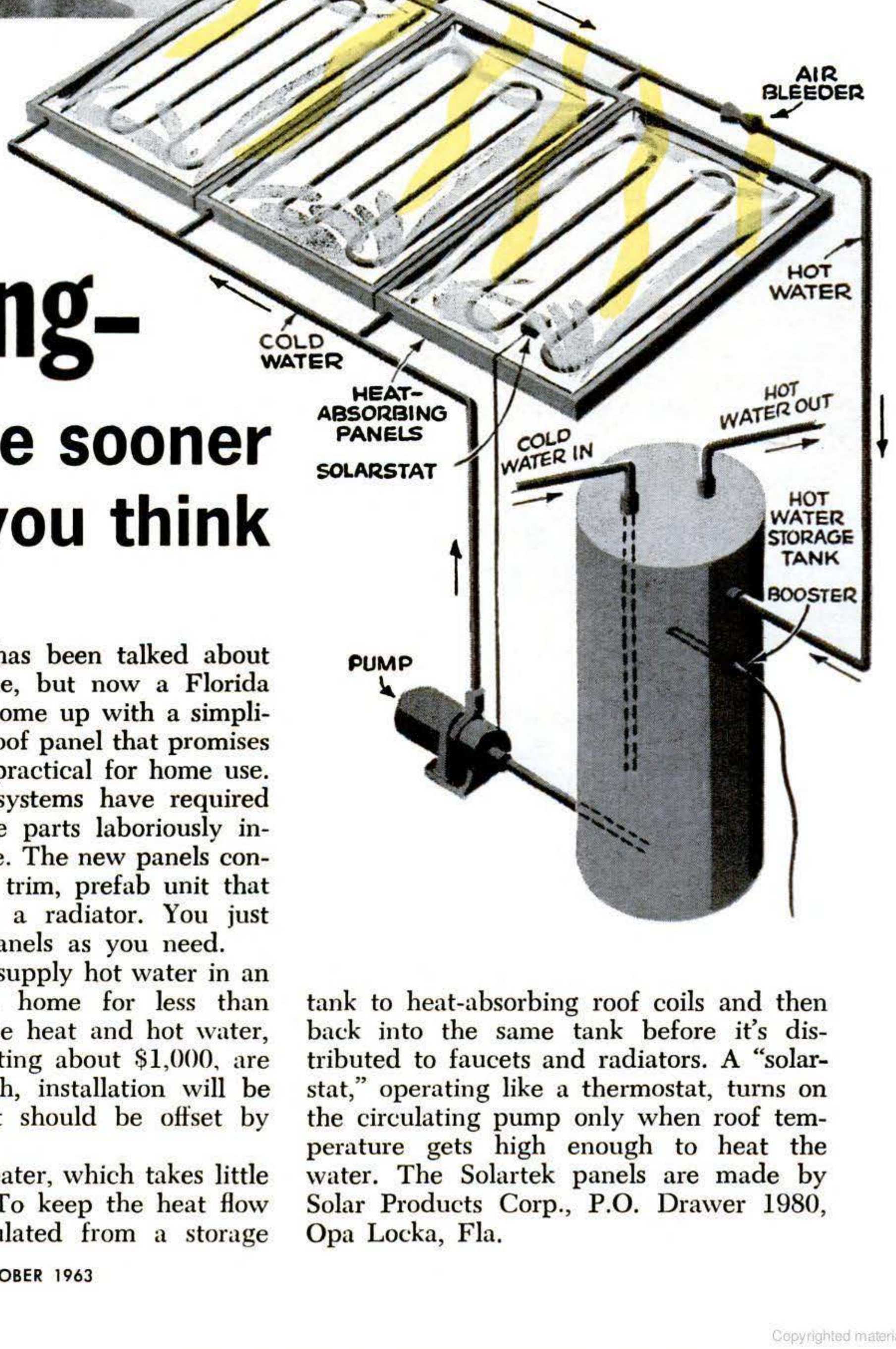
Plastic-domed roof panel contains water-circulating coils that pick up heat from sun's rays. Each is 3′ by 6′, weighs 40 pounds. Any number can be connected in rows, as shown in drawing below.

Solar Heating– here sooner than you think



SOLAR heating has been talked about for a long time, but now a Florida company has come up with a simplified heat-collecting roof panel that promises to make sun power practical for home use.

Until now, solar systems have required hundreds of separate parts laboriously installed piece by piece. The new panels contain all parts in one trim, prefab unit that installs as easily as a radiator. You just hook up as many panels as you need.

Three panels will supply hot water in an average-size Florida home for less than $300. For both house heat and hot water, 12 to 16 panels, costing about $1,000, are needed. In the north, installation will be more expensive, but should be offset by low operating costs.

A small booster heater, which takes little power, is required. To keep the heat flow even, water is circulated from a storage tank to heat-absorbing roof coils and then back into the same tank before it's distributed to faucets and radiators. A "solarstat," operating like a thermostat, turns on the circulating pump only when roof temperature gets high enough to heat the water. The Solartek panels are made by Solar Products Corp., P.O. Drawer 1980, Opa Locka, Fla.

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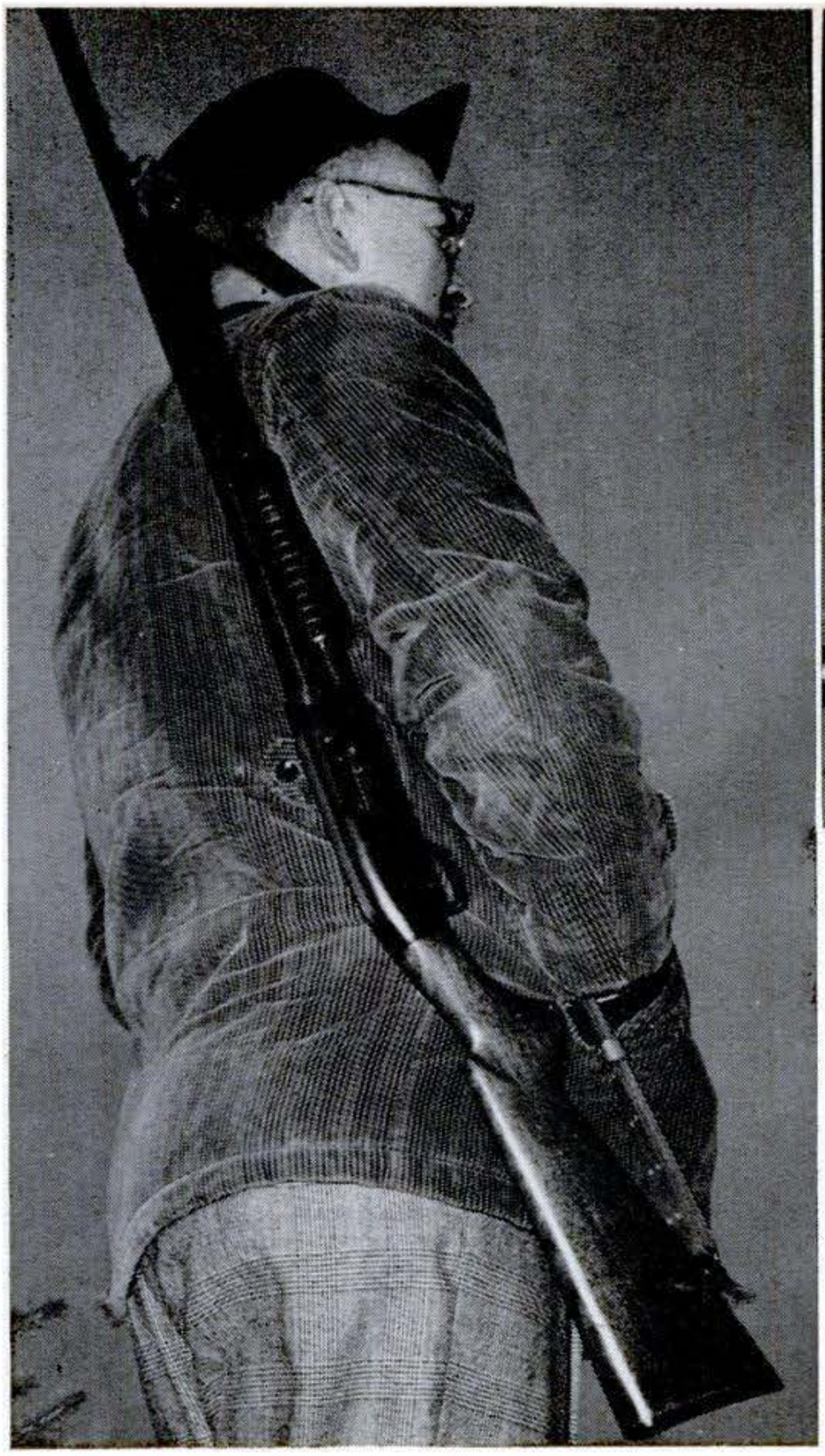
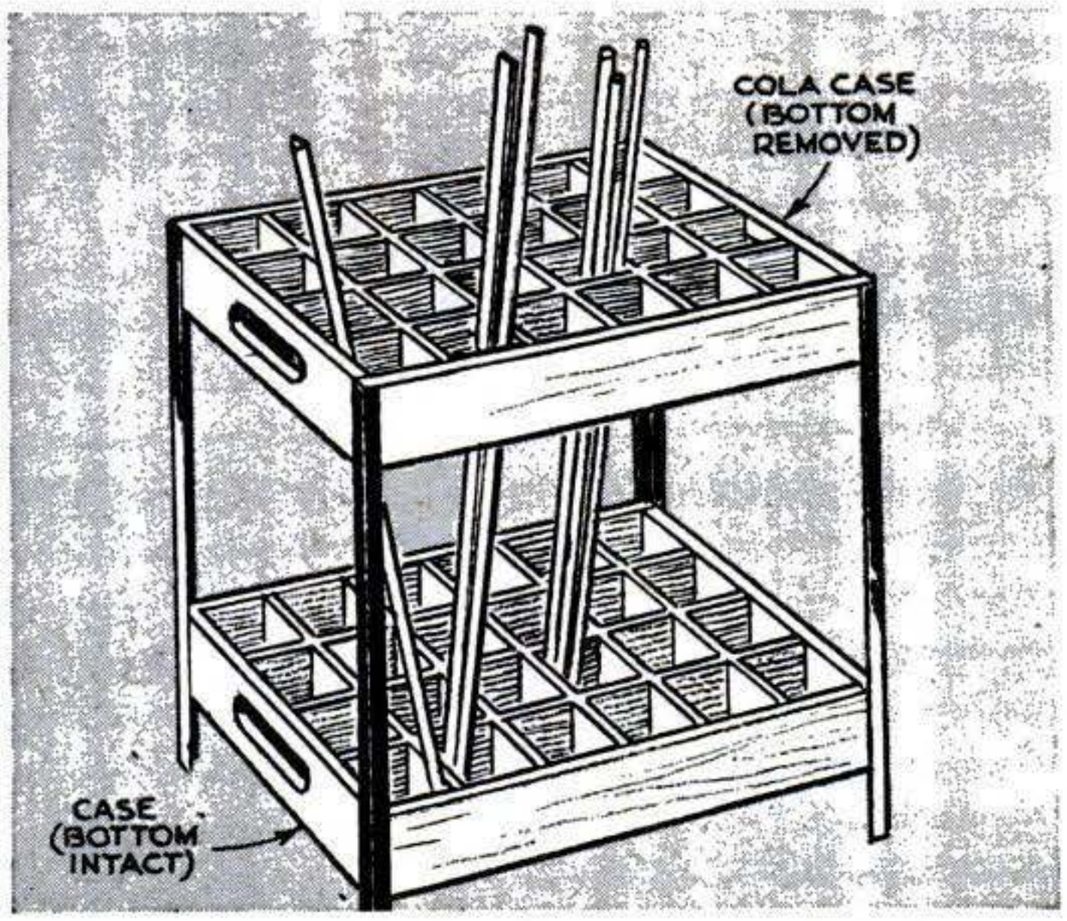


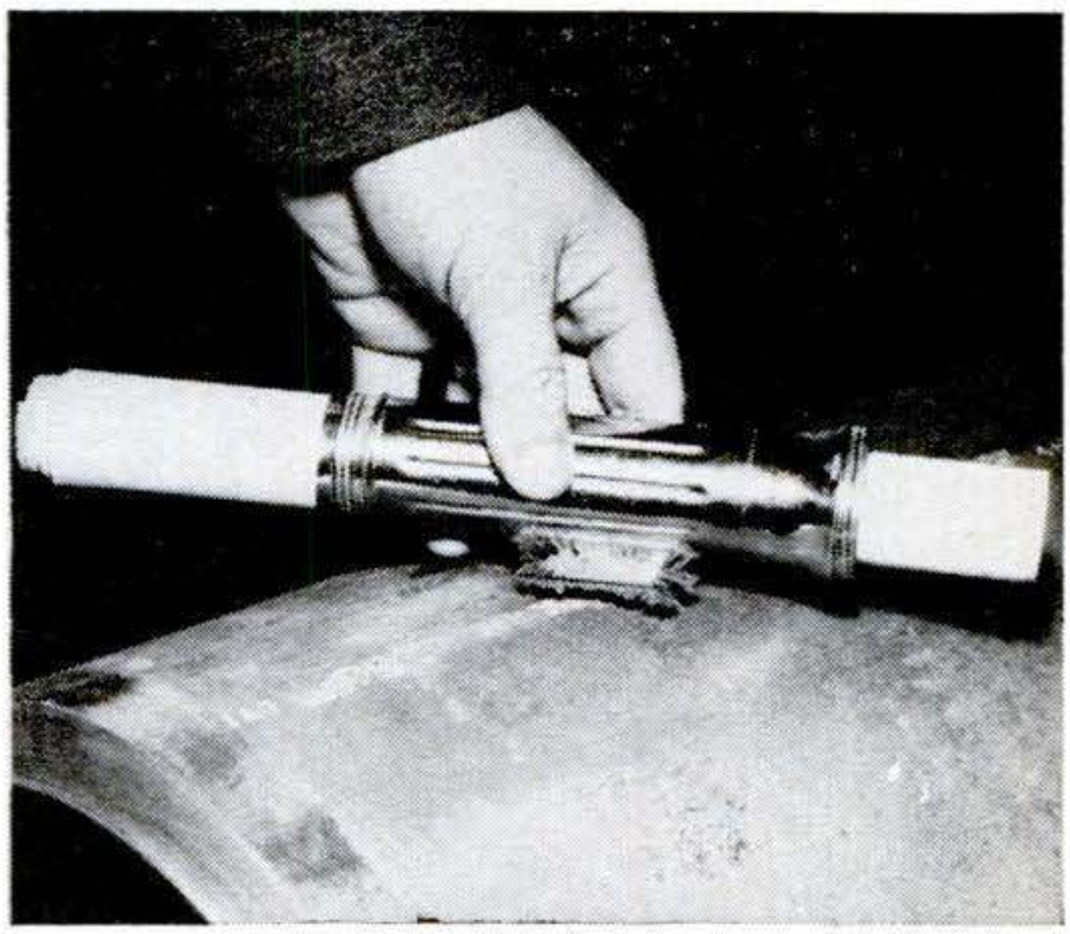
Add a sling to a shotgun—rifle style

If it makes sense to put a sling on a rifle, why not on a shotgun? You'll find it takes a big load off your hands on long hunting hikes. You can adapt a standard rifle sling easily by getting the type of U-shaped front swivel that is simply tightened around the barrel with a screwdriver, as shown above. These are available in various sizes at gun-supply stores. The rear end of the sling is held by a conventional threaded swivel that screws into the stock. —*Don Shiner, Nescopeck, Pa.*



Bottle cases sort rods and dowels

A handy storage bin for rods, dowels, and moldings can be made from two wooden soft-drink cases. Mount the cases on legs and remove the bottom from the upper one so pieces can be slipped down through the openings.—*W. H. Arthur, Dalton, Ga.*



Magnetic flashlight stores blueprints

An old flashlight with a magnet on the side makes a fine holder for rolled-up blueprints. You can carry it around with you, then stick it to any handy piece of metal to keep plans neatly rolled within reach.—*Duane Mason, Pasco, Wash.*

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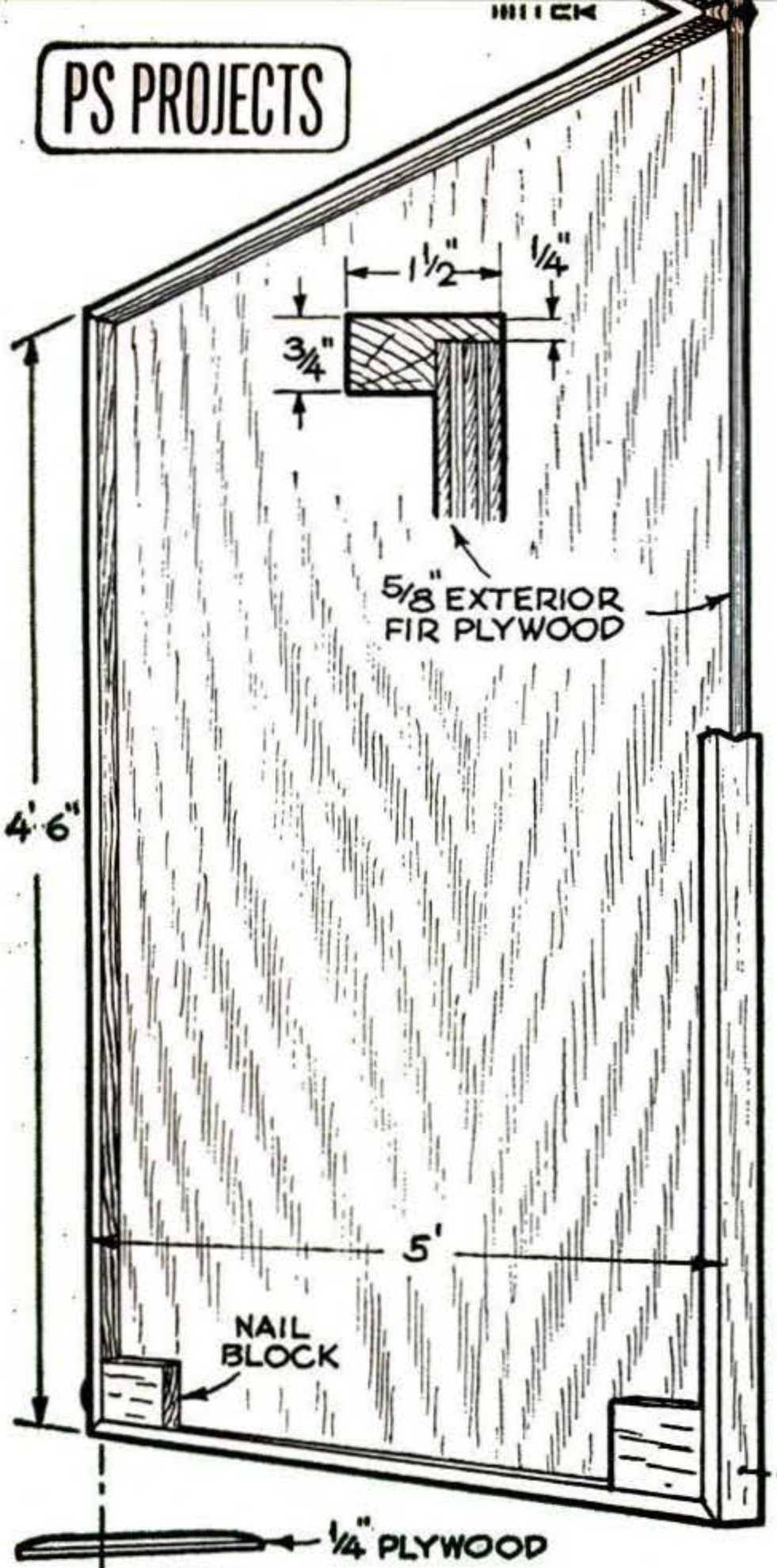

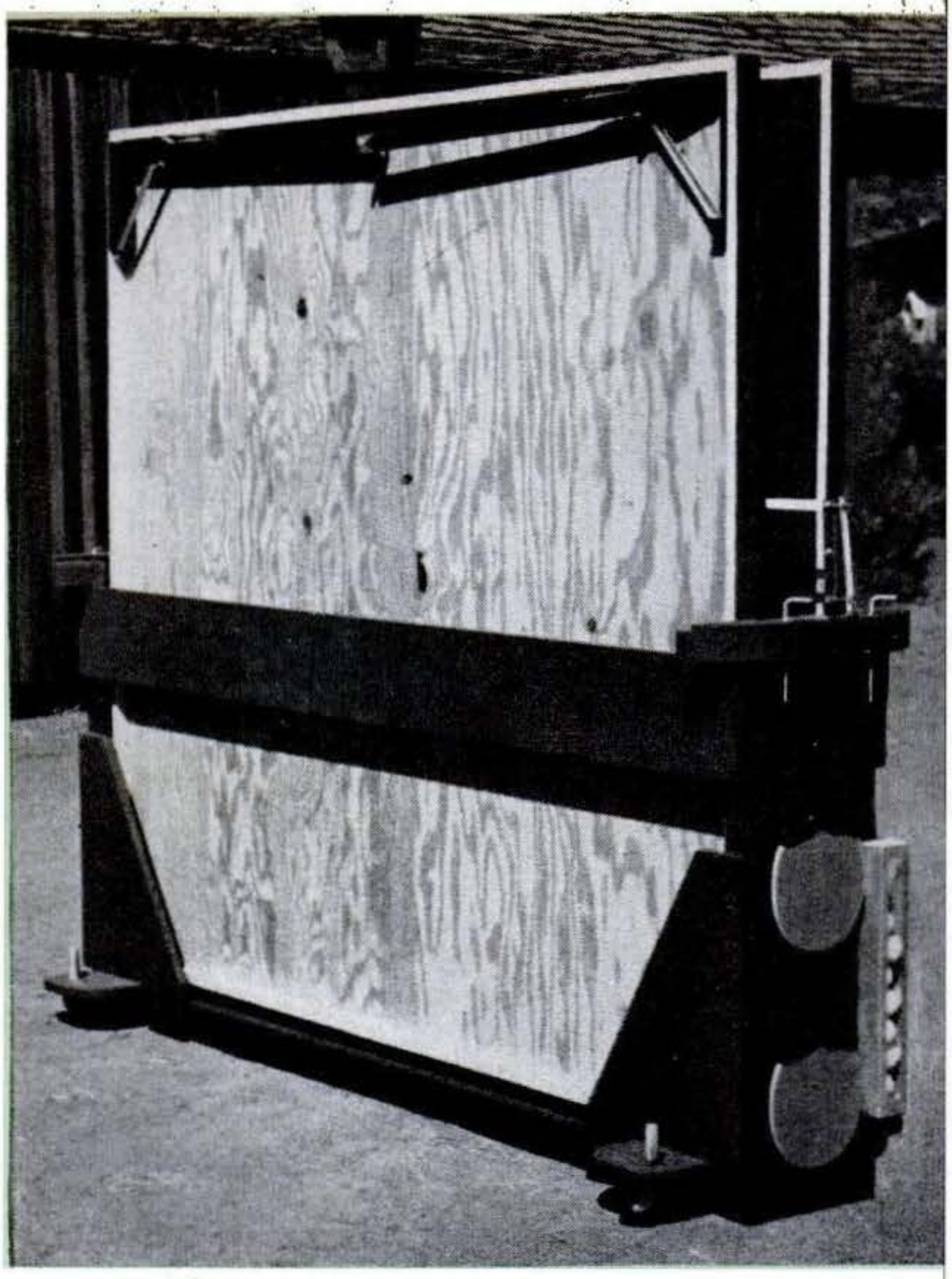

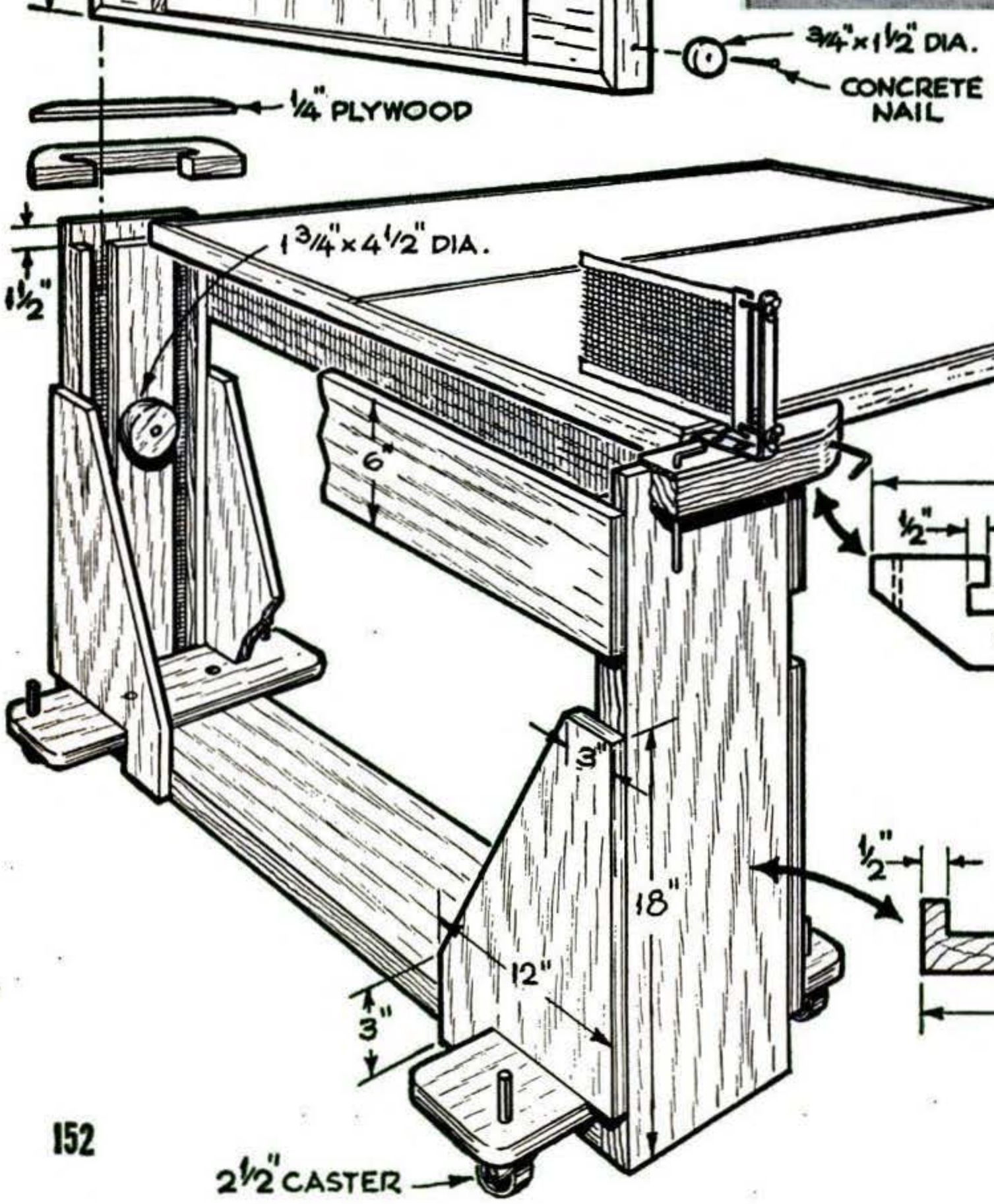

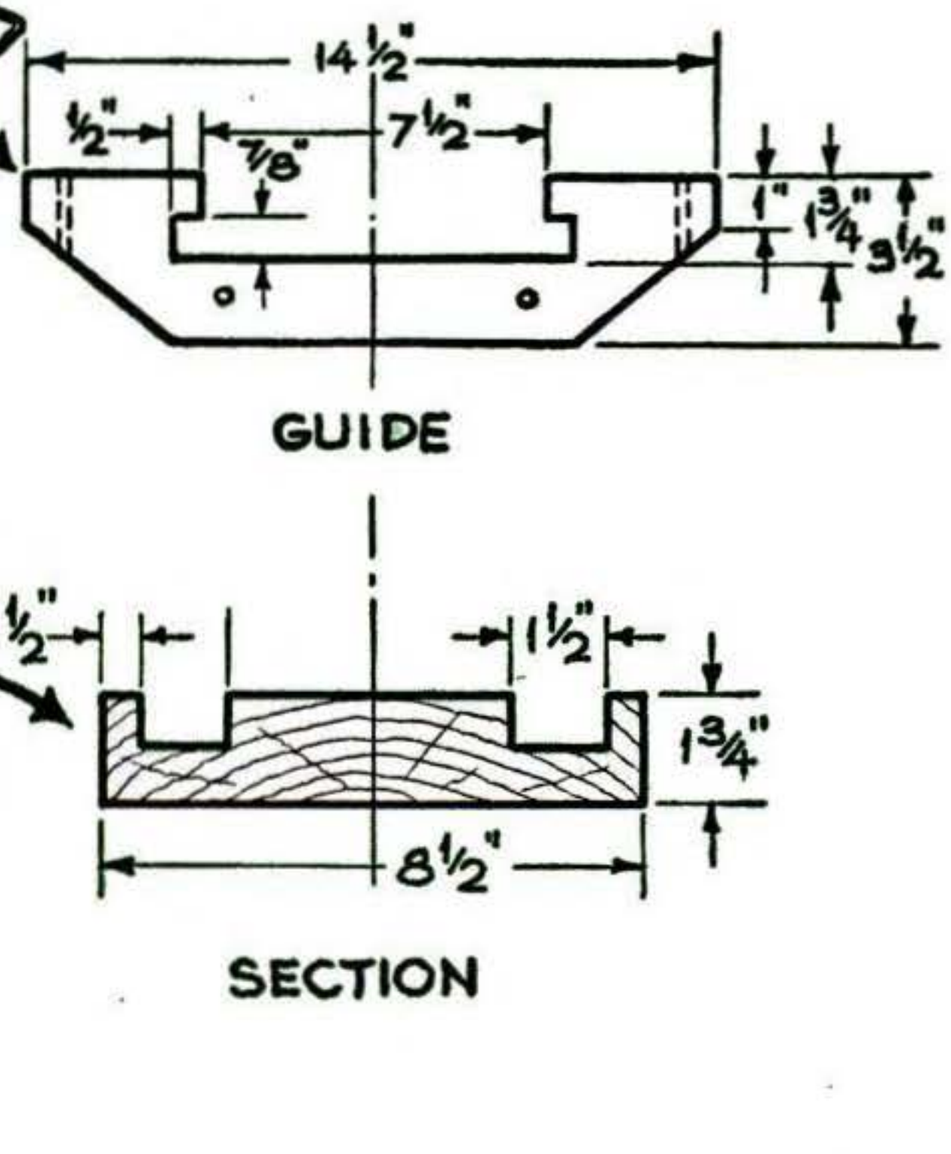

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From storage to play takes only a minute with this—

Roll-Away Table for Ping-Pong

By R. J. De Cristoforo

PING-PONG tables are cumbersome, and even the best of the fold-up models require a lot of horsing around to set up for play and store away afterward. But not this one. Its two halves fold neatly into a wheeled stand that both supports the table for use and becomes a mobile caddy when you're ready to put it away.

Casters on the bottom let you roll the table anywhere without ever lifting it off the ground. And because the net mounts on the stand, rather than on the table, you can leave it permanently set up, ready for play. Standard net brackets are used, but their clamp screws are hacksawed off so they can be screwed directly to the stand.

Smooth operation. The secret of its slick operation is a small plywood wheel nailed to each side of each table half, near its inner end. These ride up and down in grooves to guide the table sections in and out of the stand. To set up the table, you just pull each half up and swing it down level. The outer end of each half is supported on standard folding Ping-Pong table legs, available at lumber yards.

In use, the table halves butt together at the center of the stand and are supported on two cross rails. They're locked in position by L-shaped pins bent from ¼" rod that pass through the sides of the stand

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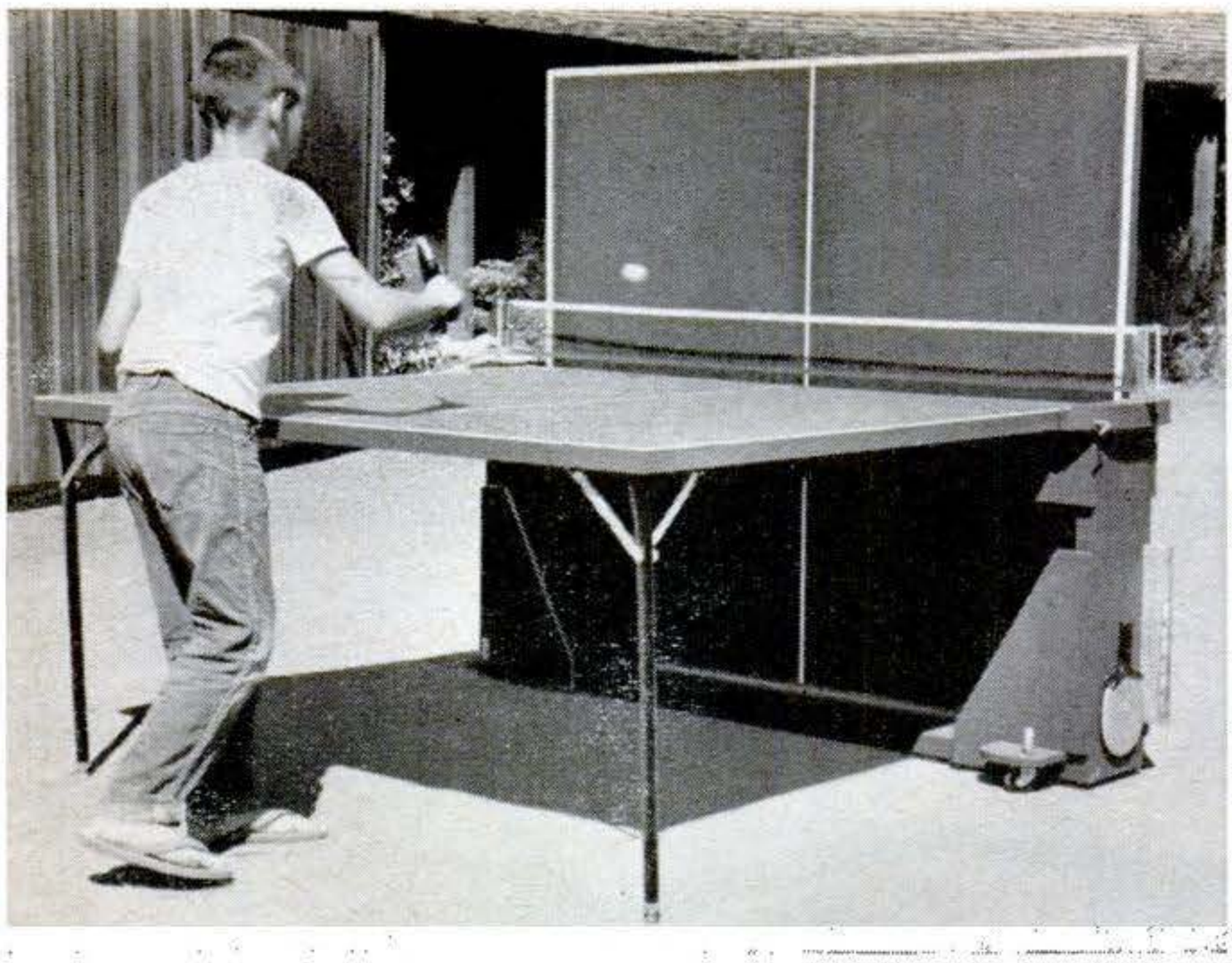
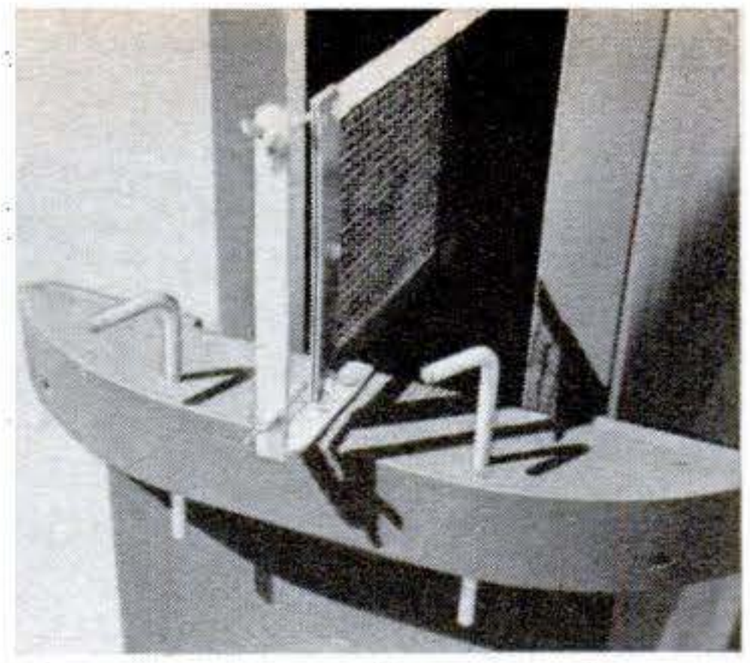




One-man game for practice sessions is made possible by using half of the table as a backboard, as at left. Note above how net mounts on the stand so it can be left permanently set up. Table-locking pins fit into storage holes when the table is not in use.

and into corner blocks. To collapse the table, the pins are removed and inserted in storage holes drilled in the top of the stand.

Making the stand. As shown here, the stand's vertical sidepieces are made from 2" lumber, grooved with a dado cutter in a table saw to form the tracks for the table's guide wheels. However, the tracks can also be built up from 1" lumber, using spacer strips to form the grooves.

The only tricky part is forming the cap blocks that go at the top of the tracks. Note that these are shaped to hook over the tracks. Cover plates are then screwed to the top of the cap blocks to enclose the ends of the tracks. These prevent the table's guide wheels from being accidentally pulled out of the tracks once the two halves have been installed. Two large plywood disks tacked to the inner face of the tracks keep the table halves from bumping each other.

Framing the table. Regulation tables call for ¾" plywood, but we used ⅝", sturdily braced by a rabbeted frame. This makes the table sections a little lighter and easier to handle without sacrificing overall rigidity.

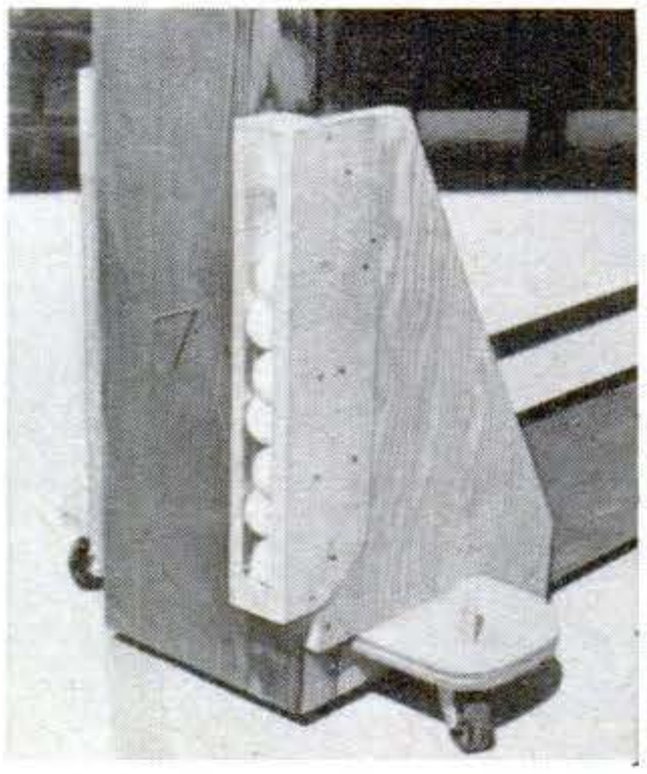
Adding the frame means you'll have to trim down a standard 5'-by-9' sheet to allow for the lip of the rabbet around the edges. This is worth the effort, though, because of the extra strength that the frame gives.

To get an absolutely smooth top, it's a good idea to cut the frame rabbet $\frac{1}{32}$" deeper than necessary. Then you can sand off the lip flush after assembly is complete. Use plenty of glue on the frame, and drive cross-locking nails through the lip and into the table *edges;* don't nail down through the top or you'll spoil the playing surface.

Regulation table height is 30". To get this exactly, you'll have to work out the stand's height after you've chosen your casters. The easiest dodge here is to mount the casters first, then add the table-supporting cross rails at the correct height. The stand's uprights can be made a bit taller than necessary and then trimmed down to the right height, too.

Finishing. Careful sanding is called for here to get a glass-smooth surface. Fill all dents and scratches, and apply a sealer before painting. Various dark-green paints are made especially for Ping-Pong tables and are available at paint stores and lumber yards.

The edges and court lines of the table are striped in white. Use masking tape to get neat lines and peel it off after the paint has just started to set. Waiting until it has dried completely will leave chipped and ragged edges. The table shown here was coated with an especially tough chalkboard paint that stands up very well. ■■



Ball holder is sheet aluminum bent into a square tube and tacked to the base of the stand. The slot in the side lets you flip balls up and out with a finger.

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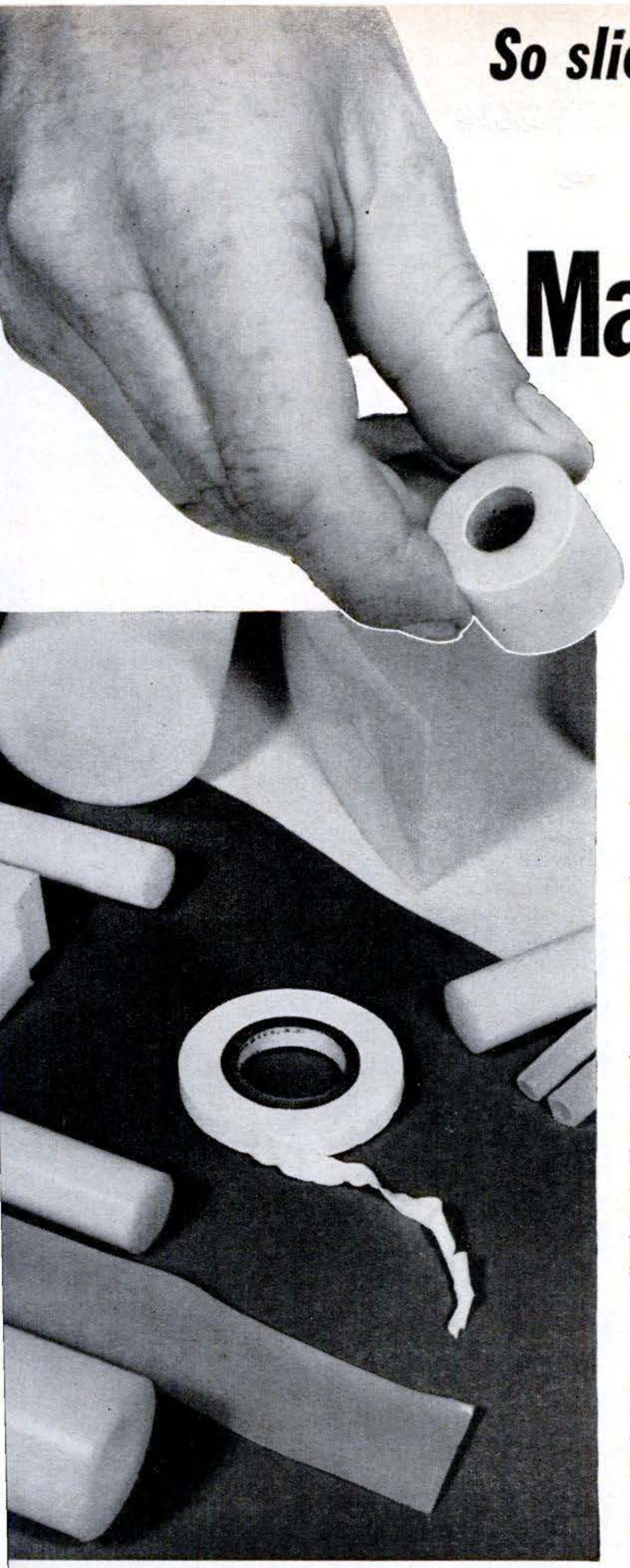

Shapes and sizes in which you buy the raw material for making plastic bearings are shown above: rods, bars, tubing, sheets, even tape. Such plastics are now sold by special stores in many cities, or you can order by mail.

So slick they need no lube!

How to Make Your Own Plastic Bearings

By Phil McCafferty

MAKING your own bearings used to be unheard of. Now it's possible, using the same three plastics that go into modern commercial bearings—Du Pont's Teflon, Delrin, and better-known nylon. With these, you can turn out almost anything from a smooth-gliding drawer slide to a heavy-duty bearing for a power shaft.

For some time now, manufacturers have been fashioning these raw materials into bearings, ranging from those that allow extended lube periods in a new car to silent nonstick zippers—actually sliding bearings. All three plastics are now available in stock sizes and shapes. You can use them for repairs and improvements around the house and shop—and incorporate them into various projects where bearings are needed.

Happily, plastic bearings perform their very best where needed most—where lubrication is impractical or apt to be neglected; where speeds and loads are relatively low; where grit or corrosion would quickly ruin metal bearings.

What plastic for what job? Nylon and Delrin are the strongest of the trio. Nylon also takes honors as the toughest. Delrin is the most rigid, easiest to machine, least apt to creep—expand and contract in use. Nylon and Teflon are best for absorbing vibration. Teflon is by far the slipperiest.

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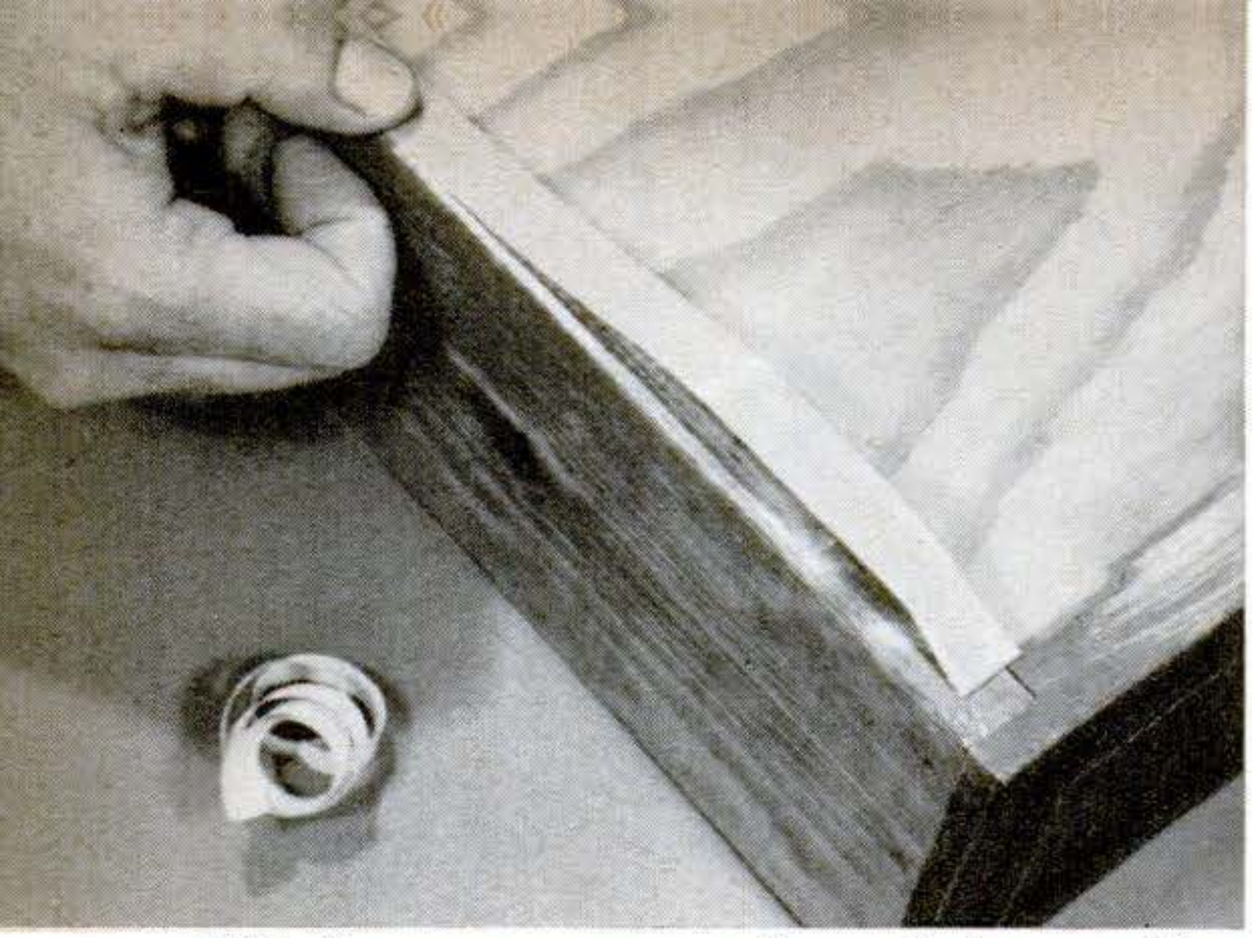
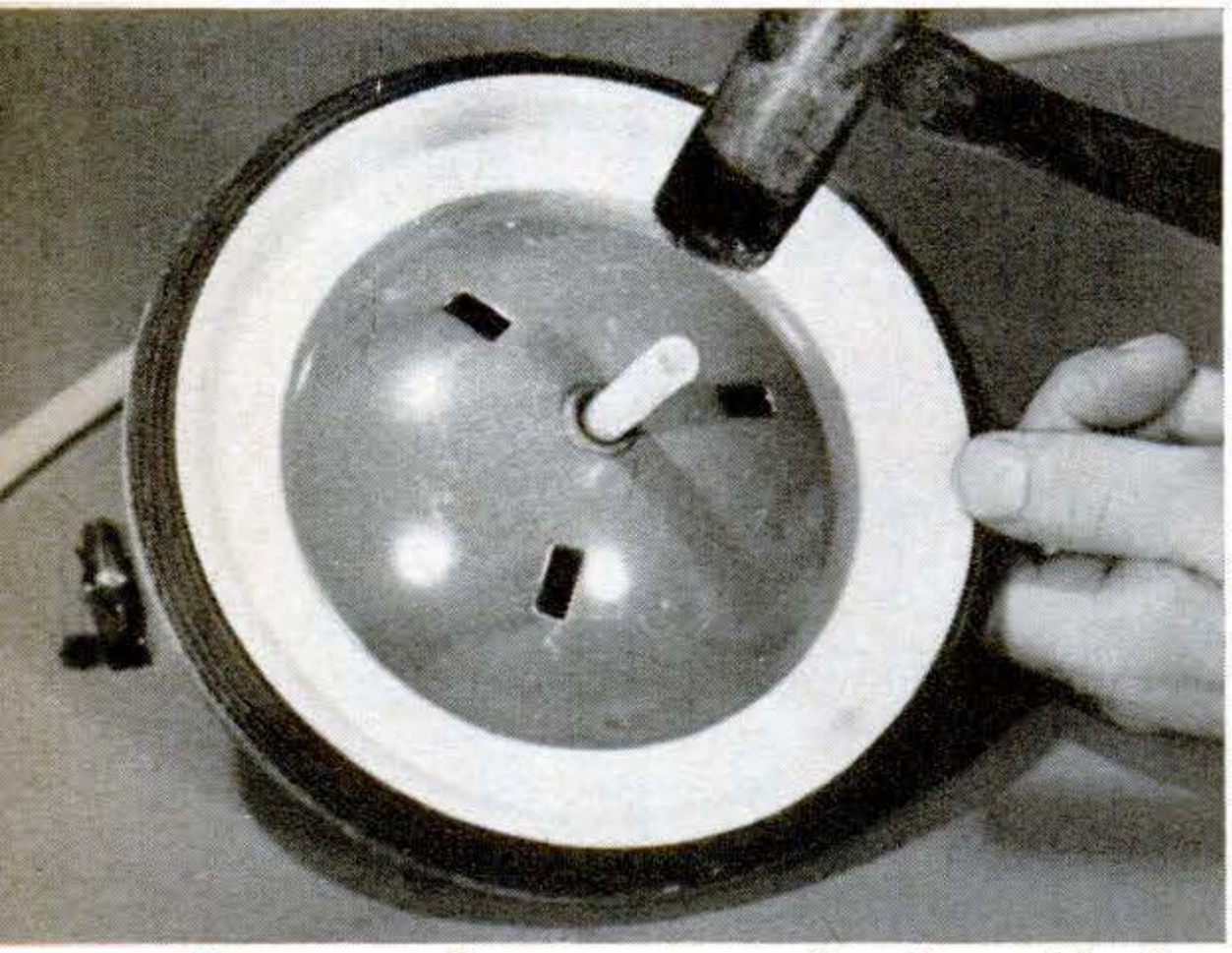
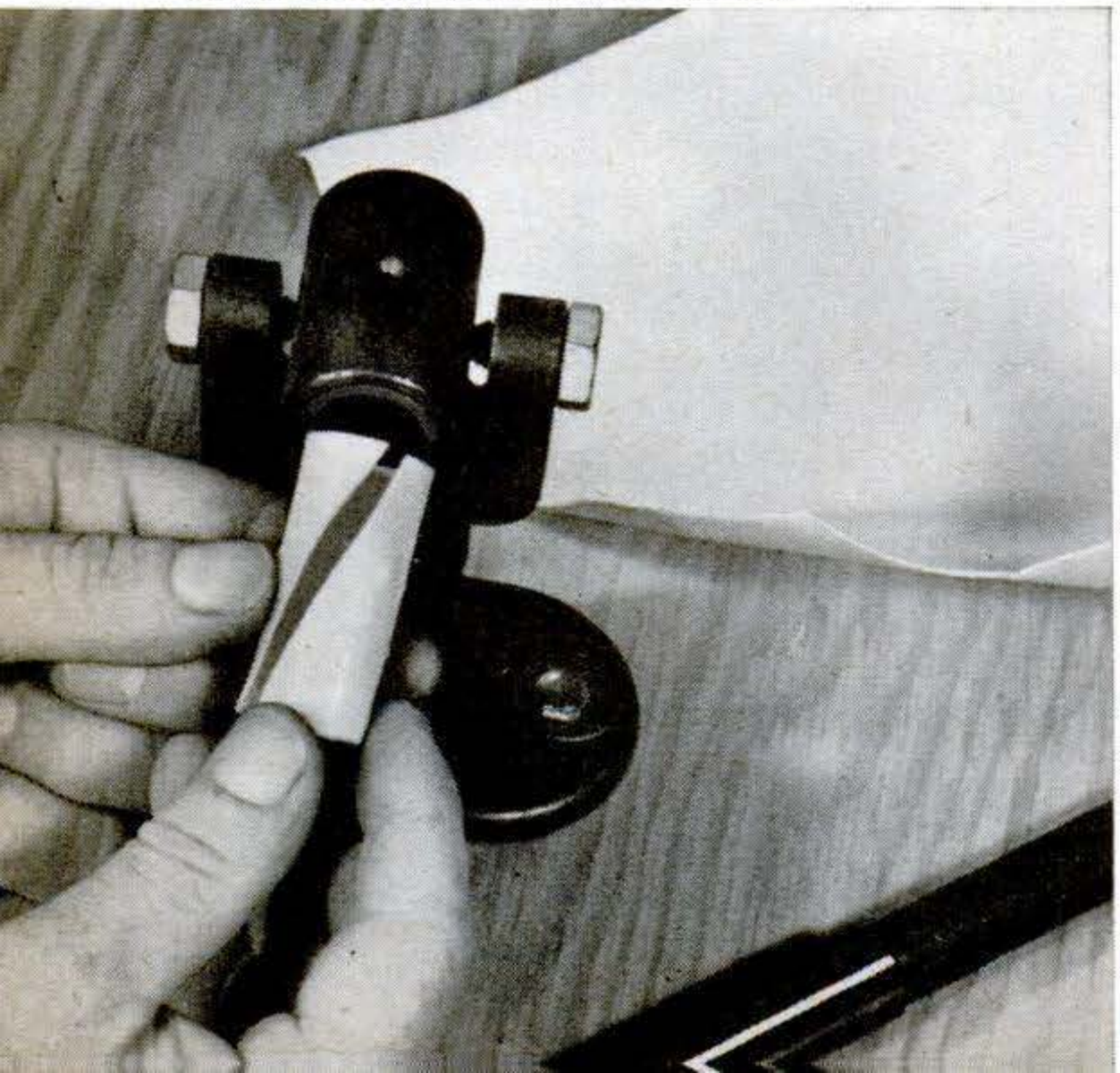


Slick drawer runners can be made by attaching strips of pressure-sensitive Teflon tape to the lower edges of the drawer. You can use the tape on many other sliding surfaces, too.



You can replace many worn bearings with plastic tubing—even the hub of a small wheel, as shown here. Remove the old bearing, press the tube into place, ream the tube to fit the shaft.

You can repair a worn bearing, leaving the old in place. Ream it out and slip in a strip of nylon or Teflon sheet, cut diagonally. Cut the wrapper a bit short to permit expansion.



Nylon has the unique property of allowing hard grit to embed itself into its plastic surface. This means that while the bearing may go out, the shaft or supported member is not as likely to be damaged by the foreign material as would be the case with metal-to-metal bearings.

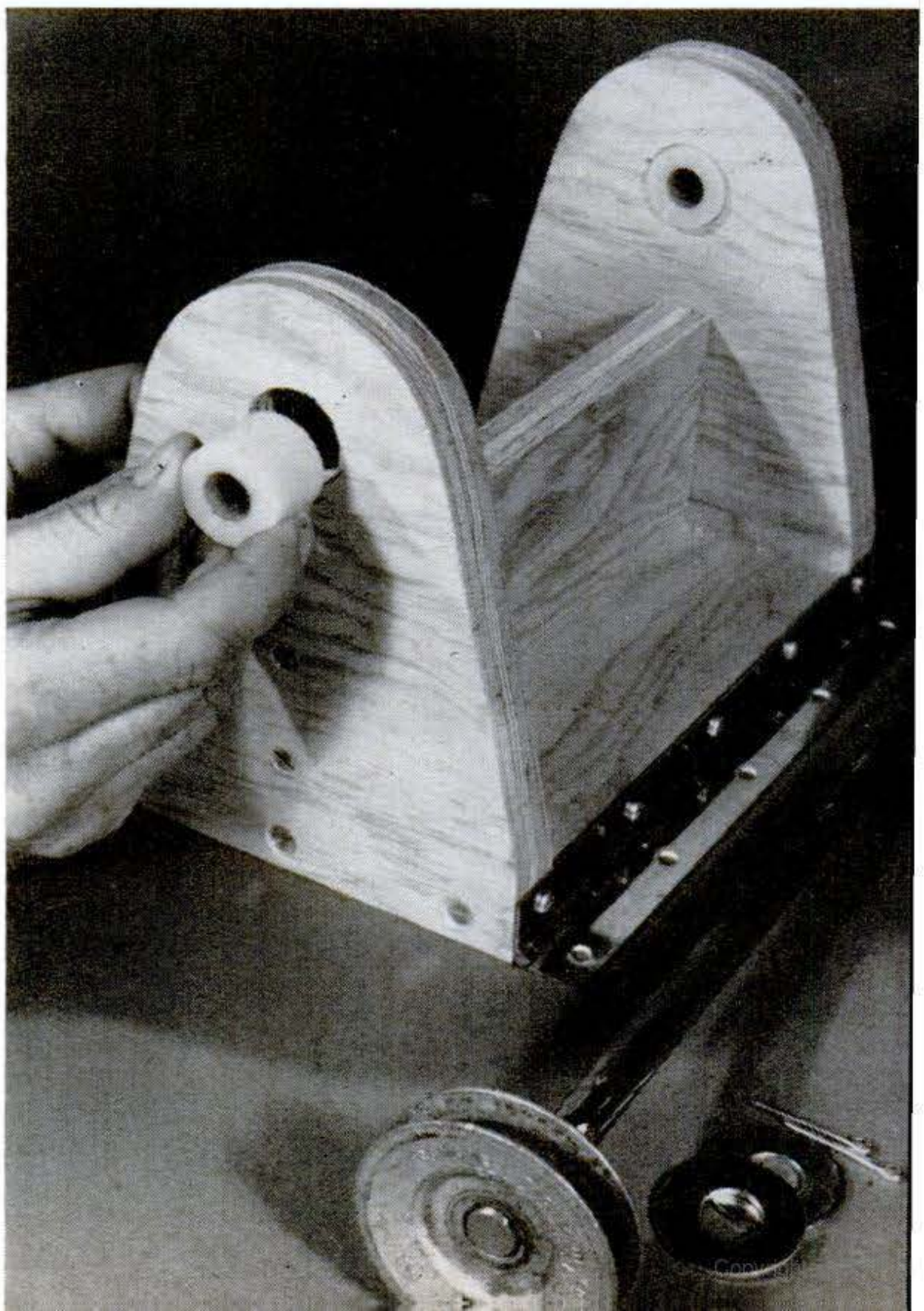
Nylon works fine with or without lubrication. With water as a lube, the plastic makes fine pump bearings and is handy for applications where water and sand are present—for tiller-line pulleys, trailer-bow rollers, lawn-mower wheel bearings.

Maximum practical temperature for nylon is about 150 degrees. But kept reasonably cool, nylon bearings resist abrasion excellently and run quietly.

Because of its toughness and resilience, nylon is also good for things besides bearings. A length of 3/16″ nylon rod is a good fish tape. It slides through electrical conduit like a greased noodle. And it will take a 350-pound pull. Saw off a chunk of 1½″-2½″-diameter rod, drill a center hole, and you have a silent-running, nonmarring replacement caster wheel that never needs lube.

Teflon has the lowest coefficient of friction of any solid material. The slippery stuff is unfazed by nearly all chemicals.

It is available in a greater variety of very thin shapes than the other two, which makes



it the choice for wraparound repair bearings, door slides, thrust washers, skids (try it on the deck of your station wagon for sliding heavy objects in and out).

Besides these handy features, almost nothing sticks to Teflon. Make, for example, a husky roller for veneering from a length of Teflon tube, a suitable shaft, and handle. Glue or cement on the laminate will simply pull off the roller.

Delrin takes to lube like nylon, but it takes loading and high temperatures better than nylon. It machines best of the trio. These features recommend it for cams and other jobs where rigidity is important.

All three are available in a variety of stock rod diameters and slab thicknesses. Nylon and Teflon are stocked in hollow and solid rods, strip, sheet, tubing, and spaghetti. Nylon also comes in square and rectangular bars. Teflon can be had in thin tapes and films.

Machining and shaping. Use common wood- and metal-working techniques. Teflon and Delrin machine quite well. Teflon works somewhat like soap. Delrin perhaps compares to very dense hardboard for workability. Nylon runs in third place for shaping with woodworking tools, but machines rather well on a lathe or drill press. The basic rule: Use sharp tools.

Keep heat to a minimum. Excessive friction tends to melt the plastics. Saw blades and drills, for example, should be smooth and free of gum or buildup. Beat the heat by using a belt rather than disc for power sanding, a bandsaw rather than a jigsaw for sawing.

Coarse-toothed saw blades work best. A "miter" circular-saw blade works wonderfully on Teflon and Delrin. Nylon is best sawed with a carbide-tipped blade.

Drilling and turning should be done with moderate speeds and coarse feeds.

Use coarse-series taps for threading, and file with vixen-type files. Cut sheet and tape with regular scissors. Punch-thrust washer holes with a sharpened metal tube.

To keep plastic bearings from working out of the hub, fasten them with thrust washers cut from sheet plastic—or extend the bearings slightly beyond the hub faces and use metal washers.

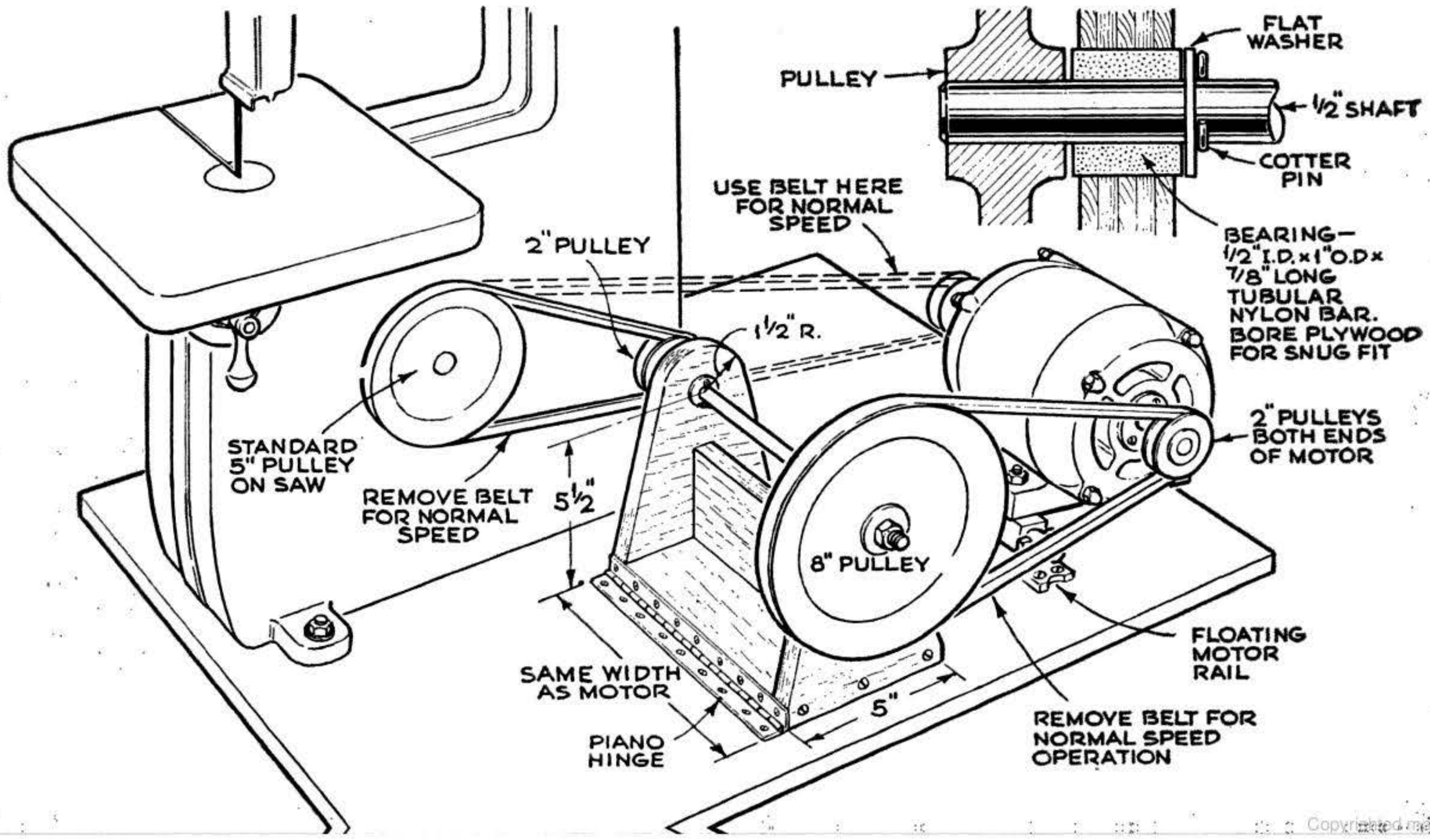
Heavy-gauge strip bearings can be held in place with countersunk screws. Or tap the strips and hold in place from the back side.

Many general-purpose epoxy glues will form reasonably good bonds between the plastics and wood or metal surfaces. However, if the bond is critical, test it first.

[*Continued on page 228*]

A fine project for any home shop: an inexpensive speed reducer

Key to the 10:1 speed-reducer jackshaft stand shown below and to the left was just 45 cents worth of nylon tubular bar. Two short sections pressed into holes in each end of stand serve as jackshaft bearings. The setup lowers the speed for metal-cutting jobs on author's bandsaw. Pulleys on both ends of motor shaft make it possible to shift speeds quickly.



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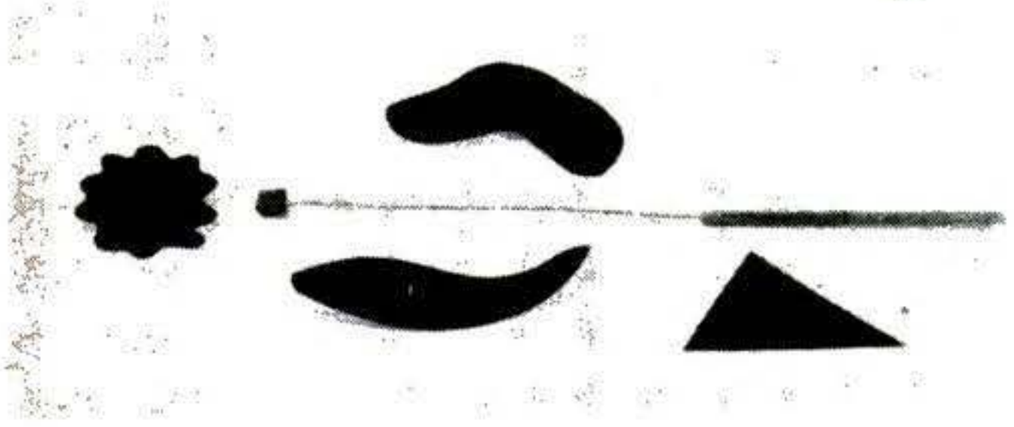
Short Cuts and Tips FROM PS READERS

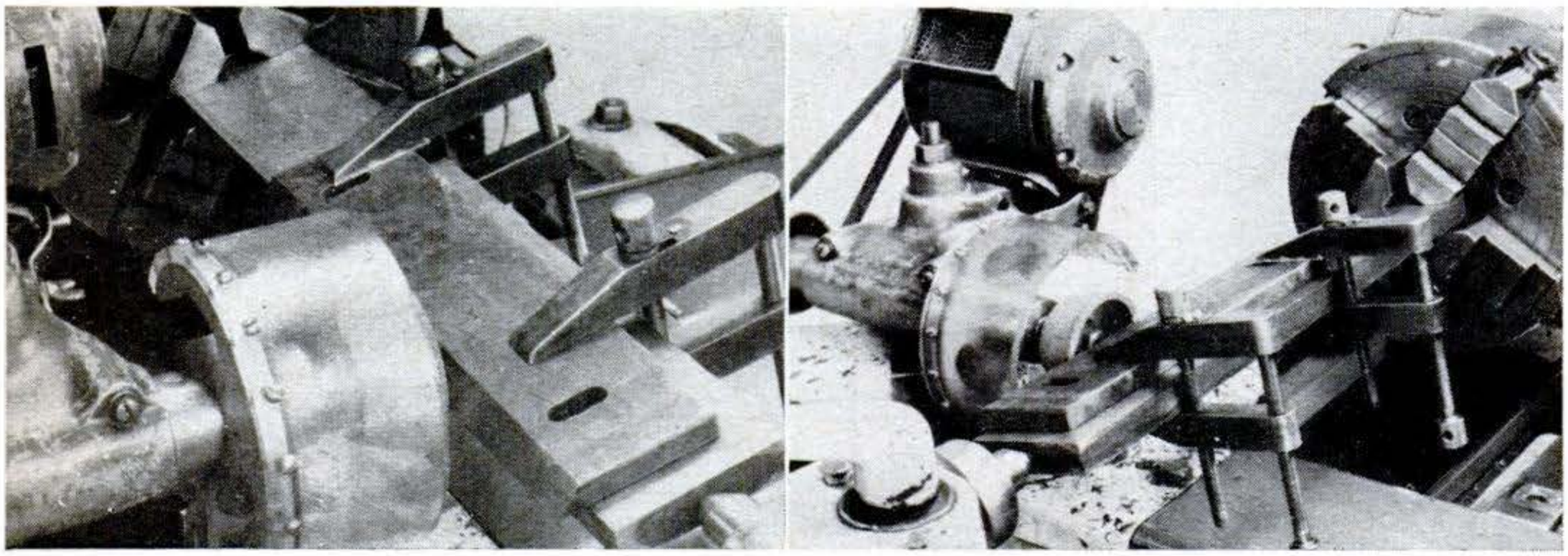
Cleaning gutters the easy way—with a garden hose

Cleaning the debris out of rain gutters is a nasty job, but not with this attachment for a garden hose. I bought a 7′ length of ¾″ pipe, heated one end, and bent it into a U shape. At the other end, I screwed on a garden-hose-to-pipe-thread adapter and hooked up the hose. Now the water flushes out leaves and dirt without my ever having to climb a ladder. You can do the same with ½″ pipe or copper tubing. Just get the correct reducing adapter to match the hose.—*Paul D. Brey, Ontario, Wis.*



Magnet holds many print-dodge shapes

A magnet attached to the end of a wire handle makes a handy print dodger. You can cut several shapes and sizes of dodging profiles from tin cans. The magnet grips each dodger firmly but permits rapid changes.—*Jack Eisner, Kew Garden Hills, N.Y.*



Sharpening shear blades in a lathe

Regrinding large sheet-metal or paper shear blades is usually difficult without a shear-grinding machine. You can, however, easily adapt a lathe and toolpost grinder to do the job. The blade is clamped to a platen made of ½″-by-3″ CR steel. The platen, with a center hole in the tailstock end, is mounted between the tailstock center and the chuck, parallel to the ways. The grinder is fitted with a 46-grit aluminum oxide wheel and traversed by slow hand feed. Any angle can be ground by rotating the chuck to the proper position.—*H. J. Gerber, Menomonie, Wis.*

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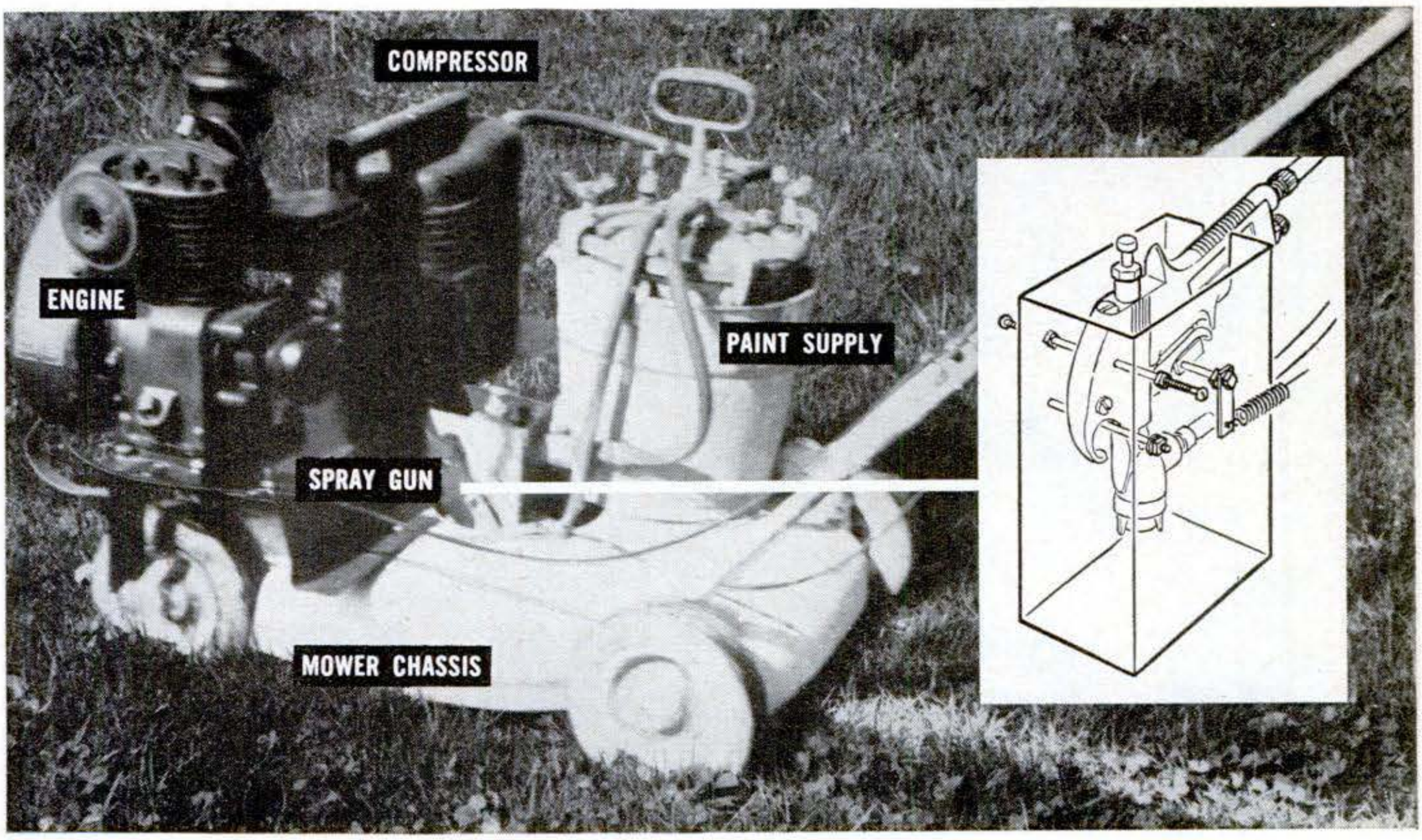
Old Mower Now Stripes Ball Fields

THIS line painter saves the Arcadia Public School at Arcadia, Ohio, about $110 each time the ball field is marked for football. Two school employees, Kenneth Anderson and Robert Good, hit on the idea of hitching an ordinary spray gun to an old power-mower chassis so the gun could be rolled along close to the ground.

A three-hp. engine drives a compressor through a pulley ratio of 2:3. The paint supply consists of a commercial spray-paint container fitted into a bucket. At the center of the chassis, the men built a 14-gauge-sheet-metal cage for the spray gun. The cage bottom is 3″ wide and 1½″ from the ground, so the gun makes a regulation 3″-wide stripe. The gun is held firmly between ¼″ stove bolts, as shown in the sketch.

Paint flow is controlled from the handle by a wire cable that moves the spray-gun trigger. The crew used four gallons of white house paint and two gallons of thinner to mark the entire field—much less than with a regular striping machine. Rain affects the paint less than it does lime, they found. Their only suggestion for improvement is a three-wheel chassis with a single middle wheel in front. Then you could use the wheel as a steering guide to follow old lines easily.



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Here's a multipurpose garage that's

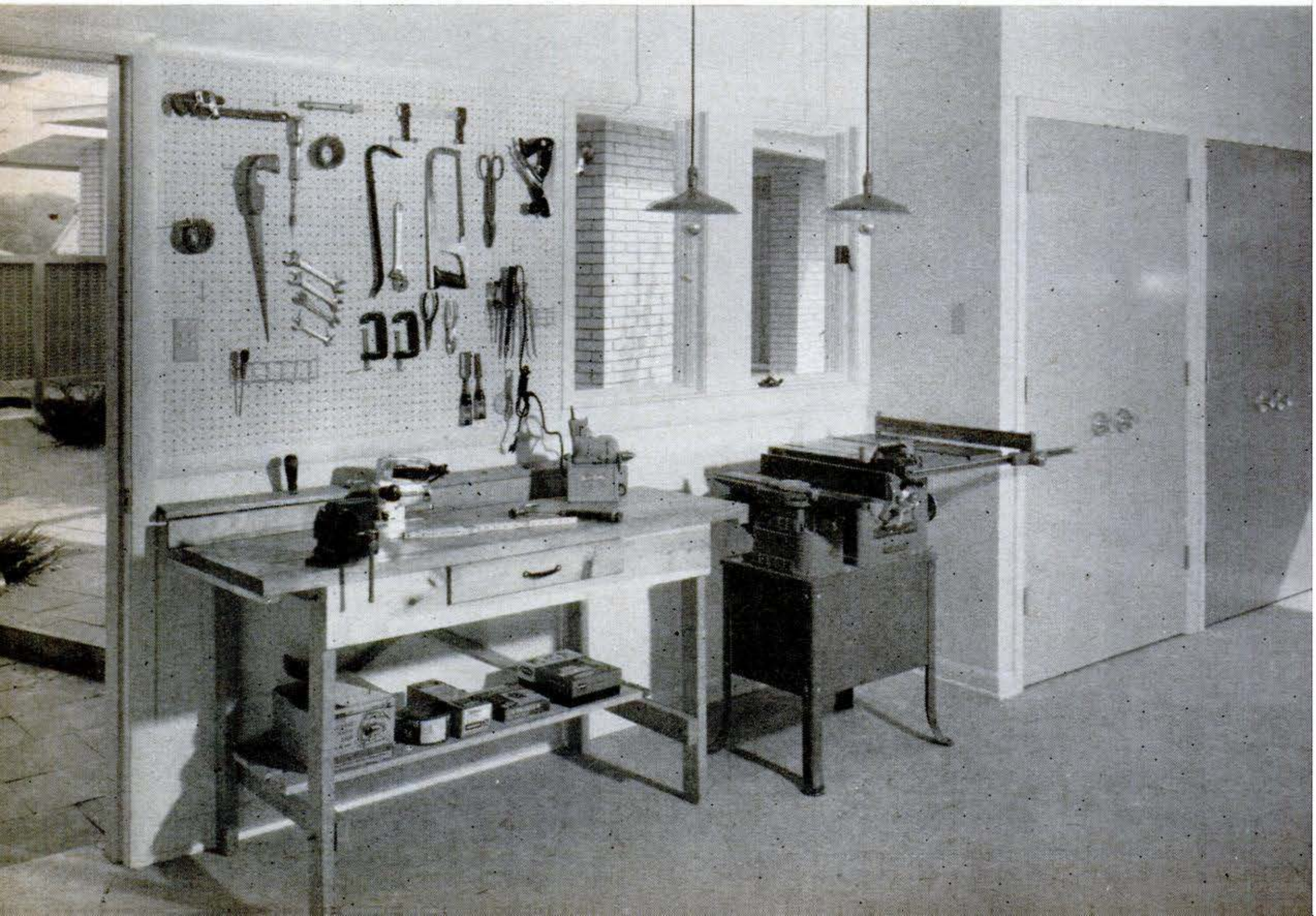
More Than a Place to Park

THE modern two-car garage represents 500 to 600 square feet of space devoted to housing cars. Today, many people turn this valuable space into extra living quarters, leaving the car out in the cold. But you don't have to give up the garage completely, as these photos show. With planning, you can have your cake and eat it, too. Your garage can also become a spacious room for shopwork, picnics, games, and other family activities.

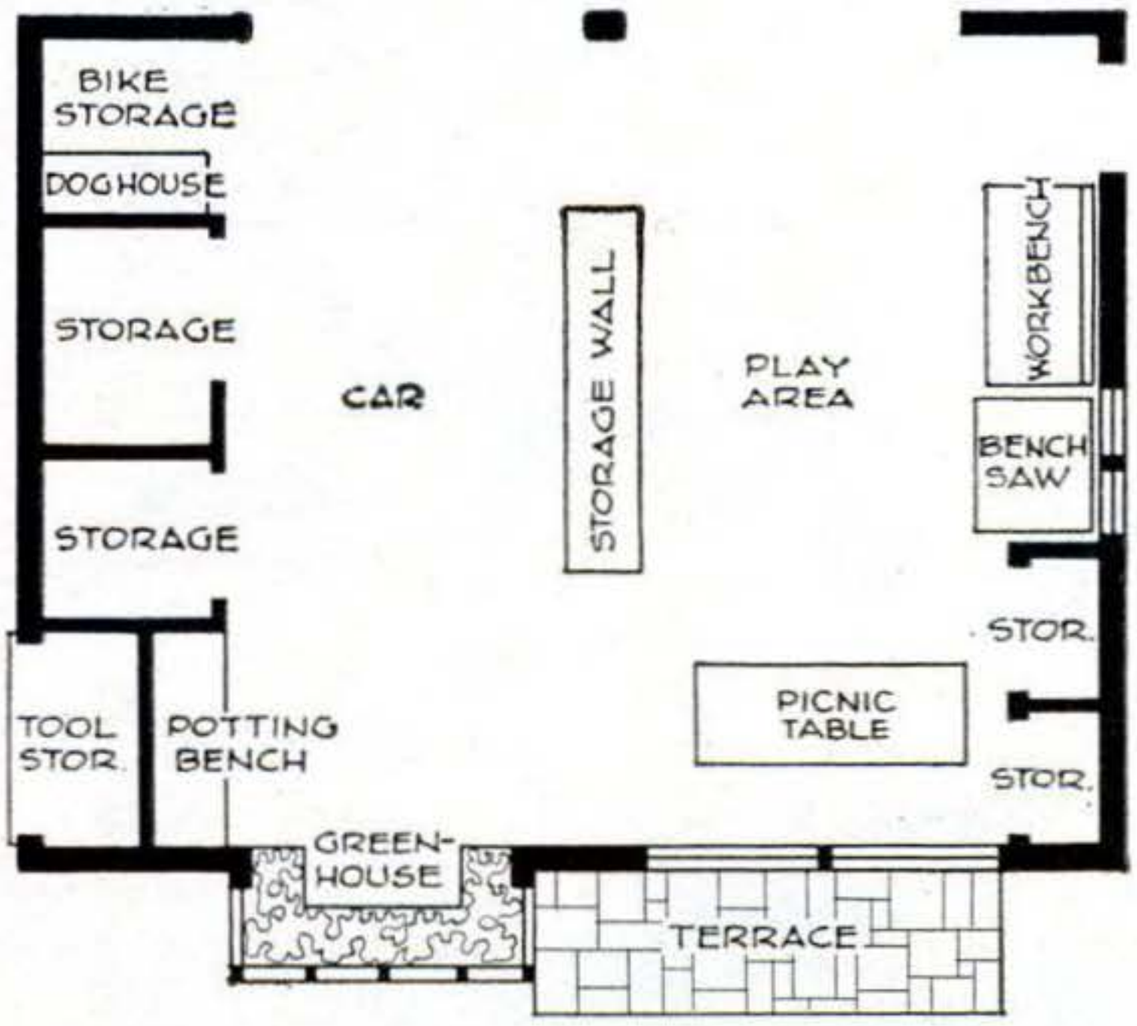
The garage shown here, designed by architect Clifford N. Wright for a model home in Detroit, has conventional roll-up doors at the front. It's the back that makes the big difference. Sliding glass doors along half of the rear wall open onto a small patio, transforming the garage into a handsome terrace room. The other half extends a few feet out into a bay under a sloping window to form a cheerful greenhouse and gardening center.

A mobile storage wall screens off the car when it's parked and rolls out of the way for parties. Many of these same ideas can also be applied to a single-car garage that shares parking room with play space.

It's a workshop, a playroom, a greenhouse,



a picnic nook, and—oh, yes—it even shelters your car



Sliding glass doors (right) turn rear of garage into a pleasant play area for buffet suppers and games. In good weather, picnic table can move outdoors onto an adjoining patio. Floor plan above shows how garage is laid out.

Compact shop, shown at left, lines one wall, taking up little space. Yet tools and sawhorses are easily moved out into the main area to give plenty of work space for large projects. Storage closets are to the right of the shop.

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Mobile storage wall hides car parked in one half of garage or can be rolled out of the way on casters to open up the entire area. It consists of two separate foot-deep shelf sections cleverly notched to fit around the center post so the post helps brace them upright.

Miniature greenhouse is made by extending end of garage out under a sloping window to let in sunlight. Flower boxes and a potting bench make this a handy gardening center. A storage port for a mower and big garden tools is behind the bench, accessible from outdoors.

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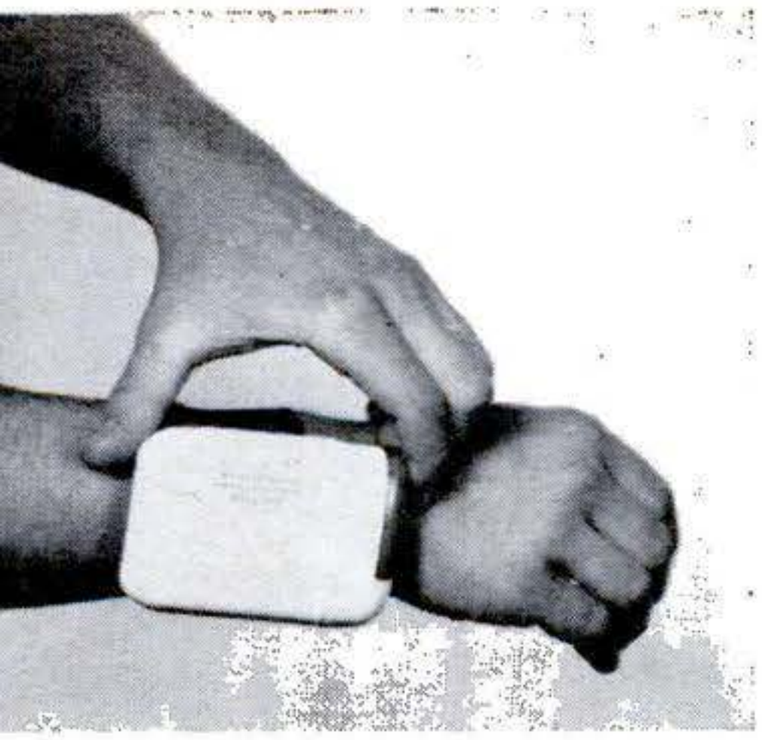
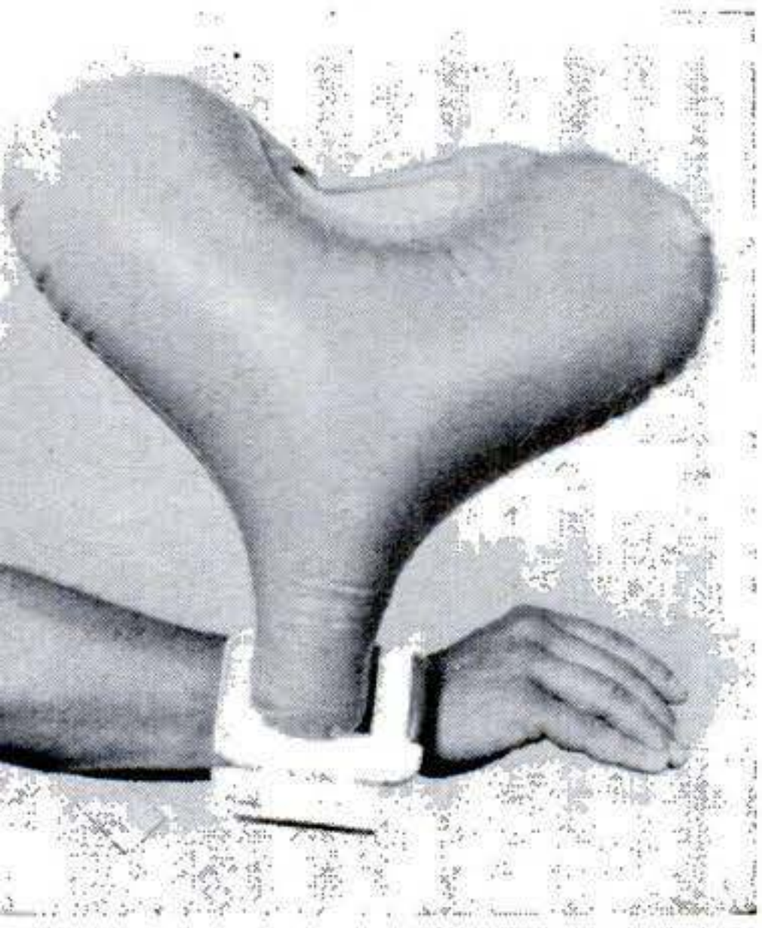


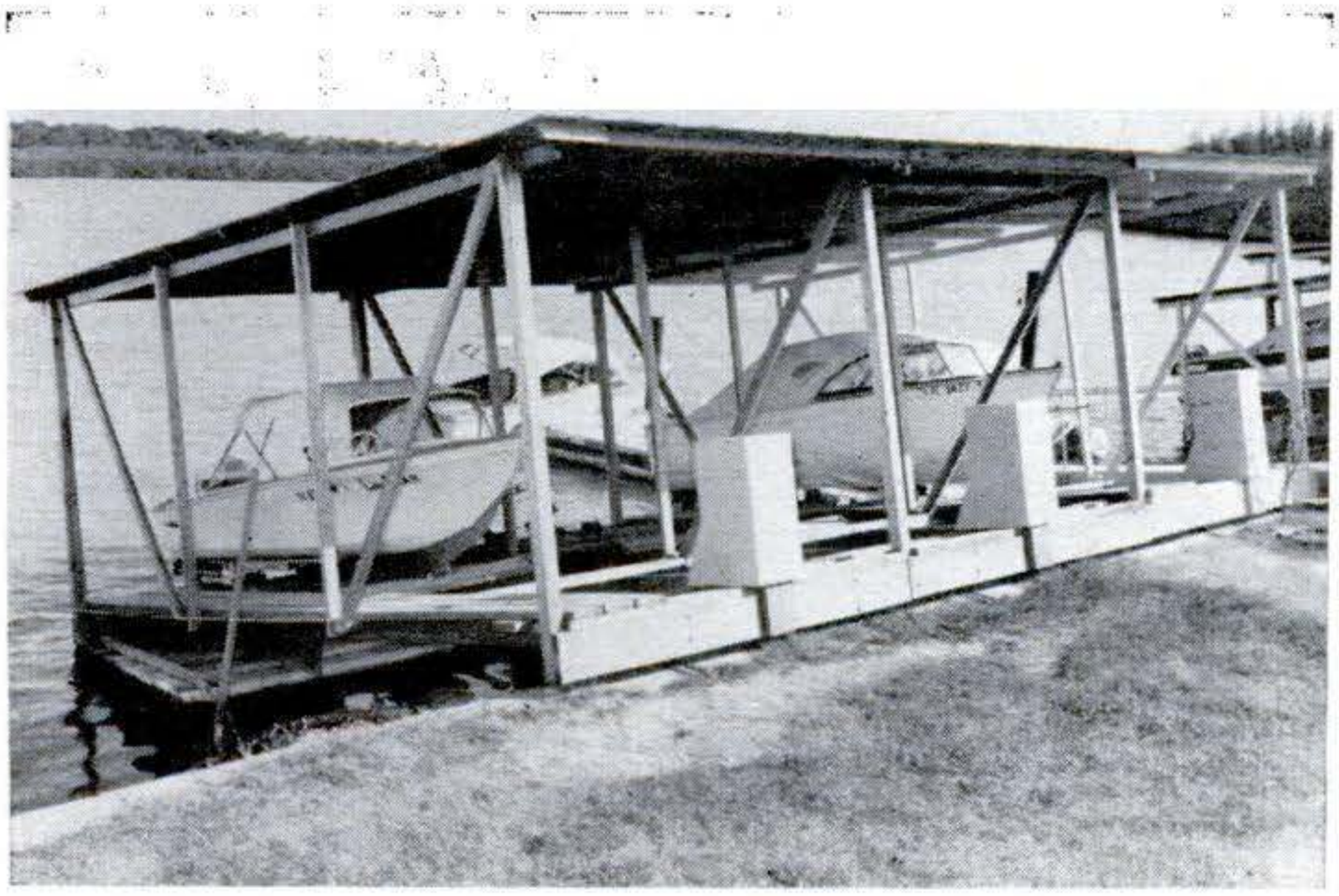
Pressing trigger punctures CO_2 cartridge to inflate the float. The case, no bigger than a cigarette pack, can also be clipped to your belt.



As float inflates, it pops open the case and expands to full size. The heart-shaped float is then tucked under the chin to hold head out of water.

"Wrist-Watch" Life Preserver Inflates in an Instant

The waters were just closing over the head of Marine Sgt. Dan Davis when a balloon popped out of his wrist watch and saved his life. This was just a dream, but from it came the real-life version above. You press a button on a small plastic pack strapped to your wrist and out pops a life-saving float, inflated from a CO_2 cartridge. The float supports a 200-pound man, folds up for re-use. Called Aqua-Aid, it sells for $4.95 from Davis & McGill, Inc., Saint Pauls, N. C.



Floating boathouse rides with the tide

No matter how high or low the tide is, your boat is always stored out of the water with this floating dock. The inner end is hinged at the shore, while the outer end rides on Styrofoam floats. Rollers ease the boats up track-like ramps. The dock was devised by Indian Rocks Fuel & Marine Co., Indian Rocks Beach, Fla.

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PS ELECTRONICS

This homemade electronic-flash timing light ends the dark ages for car tune-ups

Brilliant Flash Times Your Engine

By Ronald Benrey

UNTIL now only a pro mechanic could afford the luxury of owning a powered timing light. We Saturday-afternoon tinkerers huddled in dark corners and tuned our engines by the puny red glow of neon timing lights. Happily, the dark age is over. You can become an enlightened home mechanic by building your own xenon timing light. All it takes is about $15 worth of electronic parts, $5 for the case and trimmings, and a few hours of your spare time.

The xenon timing light is a kissing cousin of the electronic flash units used by photographers. Its heart is a miniature xenon flash lamp: a thin glass tube with an electrode at each end and filled with xenon gas at low pressure. The circuit is very simple: A transistorized *DC-DC converter* converts the low-voltage DC from your car's battery to high-voltage DC, and charges an *energy-storage capacitor* to about 400 volts DC. This capacitor is connected across the flash tube. Two or three turns of very fine wire wrapped around the flash tube form a *trigger electrode,* which is connected to the No. 1 spark-plug lead via a length of high-voltage ignition cable.

Each time the No. 1 spark plug fires, a very-high-voltage pulse is applied to the trigger wire. The xenon gas in the flash tube breaks down, changing suddenly from an electrical insulator to a conductor, allowing all of the electrical energy stored in the capacitor to discharge through the flash tube, producing a short, intense burst

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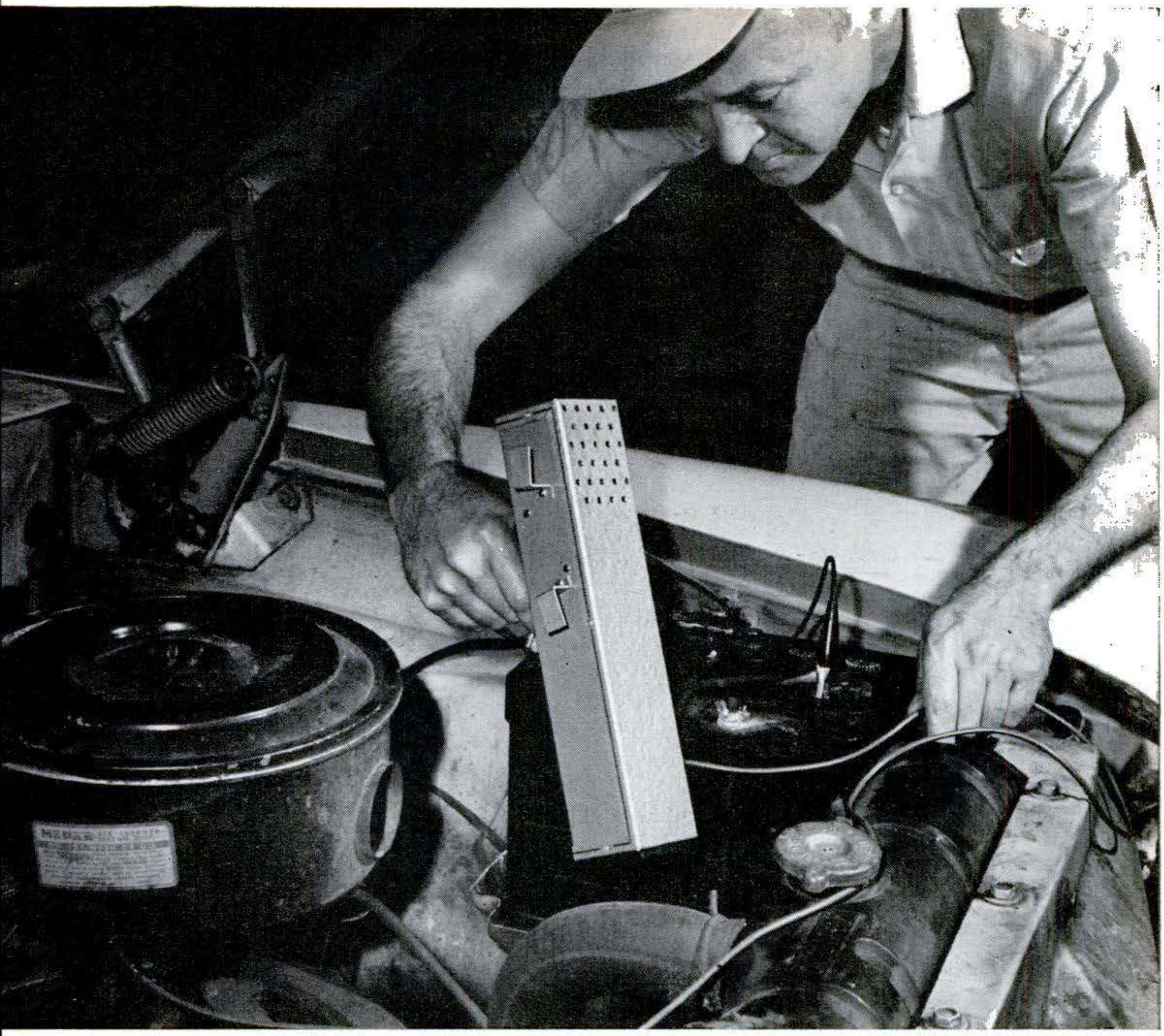

of blue-white light. After every discharge the xenon gas becomes an insulator again, enabling the energy-storage capacitor to recharge.

Putting it together. The timing light is built into an aluminum Minibox, which serves as both chassis and case. A movie-camera pistol grip (see parts list) bolted to the Minibox makes it easy to handle the timing light under the hood. Power leads, which run to the car battery, are brought in through a small hole drilled in the base of the pistol grip. A spring-return toggle switch, mounted slightly forward of the pistol grip, makes a convenient on-off trigger switch.

The two power transistors, TR1 and TR2, dissipate a good deal of power as heat when the circuit is operating. To help them stay cool, mount each one on a small heat sink made from a piece of scrap aluminum. The metal case of a power transistor is one of its leads, so the two heat sinks must be insulated from each other and the Minibox. Do this by bolting the heat sinks to a small piece of fiberboard. A pattern of small holes drilled in the Minibox above the transistors will aid ventilation.

The energy-storage capacitor, C1, and transformer, T1, are bolted to the Minibox. Placement of these components isn't critical, but C1 should be mounted so that its terminals can't short-circuit to the Minibox, and T1 should be placed where its weight doesn't upset the balance of the timing light.

The xenon flash tube is mounted on the

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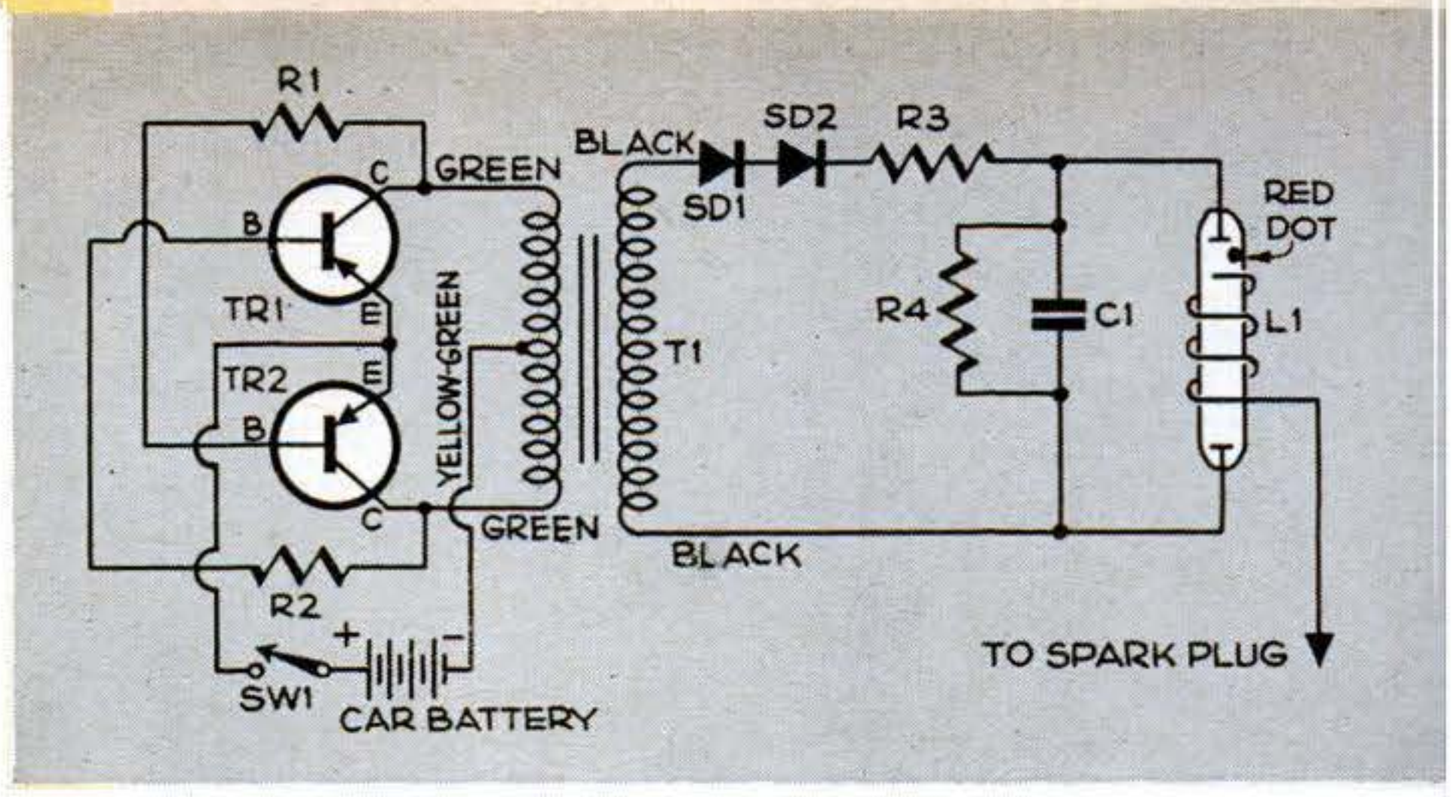

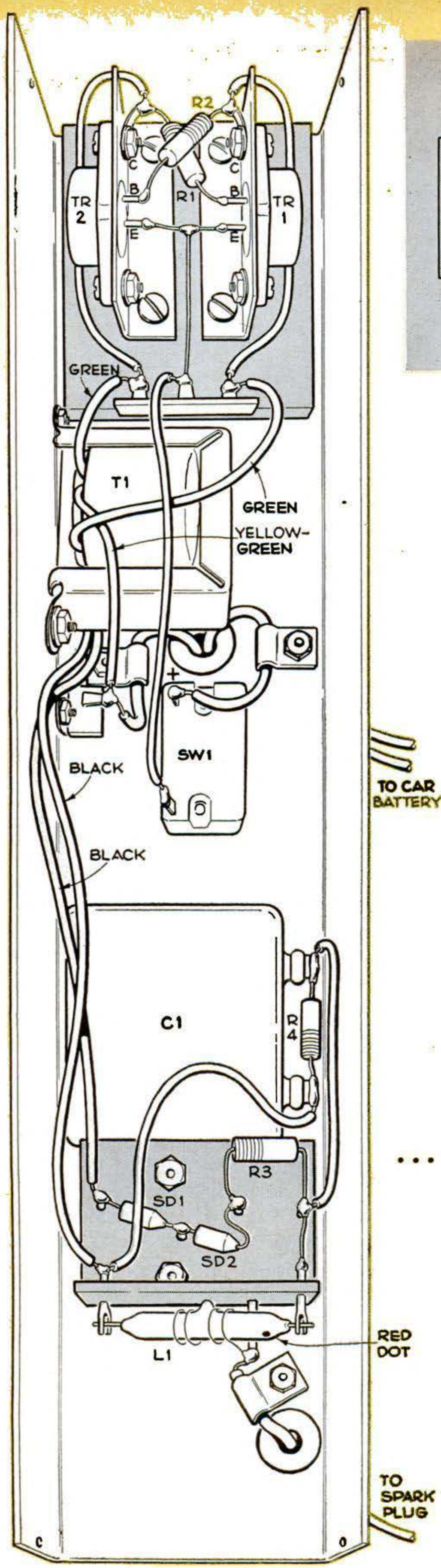

crossbar of a T made by cementing together two small pieces of perforated phenolic board. The flash tube's leads are held by two push-in terminals (flea clips). Notice that one end of the flash tube is marked with a small red dot. The corresponding terminal must be connected to the *positive* side of the power supply.

The high-voltage silicon rectifiers, SD1 and SD2, and charging resistor, R3, are mounted on the stem of the perforated-board T. Use push-in terminals as wiring points. Grasp the diode leads with long-nose pliers when soldering the diodes in place. The pliers will carry away heat that might damage the diode.

Don't use ordinary hookup wire to connect C1 to the T; it's insulation isn't intended to hold off 400 volts. A good choice of wire is 5,000-volt insulation test-lead cable available at radio-supply stores.

The light output of the timing light can be improved by mounting a small lens in the end of the Minibox. (I used a lens from an inexpensive pocket magnifier.) Look for one with the shortest focal length you can find—about 2″ is fine. To find the focal length, focus the light from the sun, or a

PARTS LIST

R1, R2—820-ohm, 1-watt carbon resistor
R3—1,000-ohm, 1-watt carbon resistor
R4—100,000-ohm, ½-watt carbon resistor
C1—2-mfd., 400-volt, bathtub capacitor (Aerovox P30ZN)
TR1, TR2—2N554 power transistor (Motorola)
T1—6.3-volt, 0.6-amp., filament transformer (Stancor P-6465)
SD1, SD2—1N2071 high-voltage silicon rectifier
SW1—SPST spring-return toggle switch
L1—General Electric FT-30 xenon flash tube. (Available through dealers handling GE photographic flash equipment. Write to Photo Lamp Div., GE, Nela Park, Ohio, for name of nearest distributor.)
Misc.—Kodak D350 movie-camera pistol grip, 12″ x 2½″ x 2¼″ Minibox, lens, high-voltage wire, alligator clips

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distant light bulb, on a white card. Measure the distance from the lens to the card when the spot of light is smallest and most clearly defined.

Make a lens mount by cutting a square of plastic or hardboard to fit the end of the Minibox. Use a hole saw or fly cutter to cut a hole in the center of it slightly smaller than the outside diameter of the lens. Cement the lens to the mount with epoxy glue. Fasten the mounted lens in place with epoxy or small screws.

Position the flash-tube mount so the tube will be centered on the axis of the lens and at a distance behind the lens equal to the focal length.

Light output can be further improved by enameling the mounting board white. Or you can experiment with a reflector, bent from thin, polished sheet aluminum, behind the tube. This, of course, would require precautions to keep from shorting the flash-tube terminals. I found, however, that I got plenty of light to work in subdued daylight without going to the extra trouble.

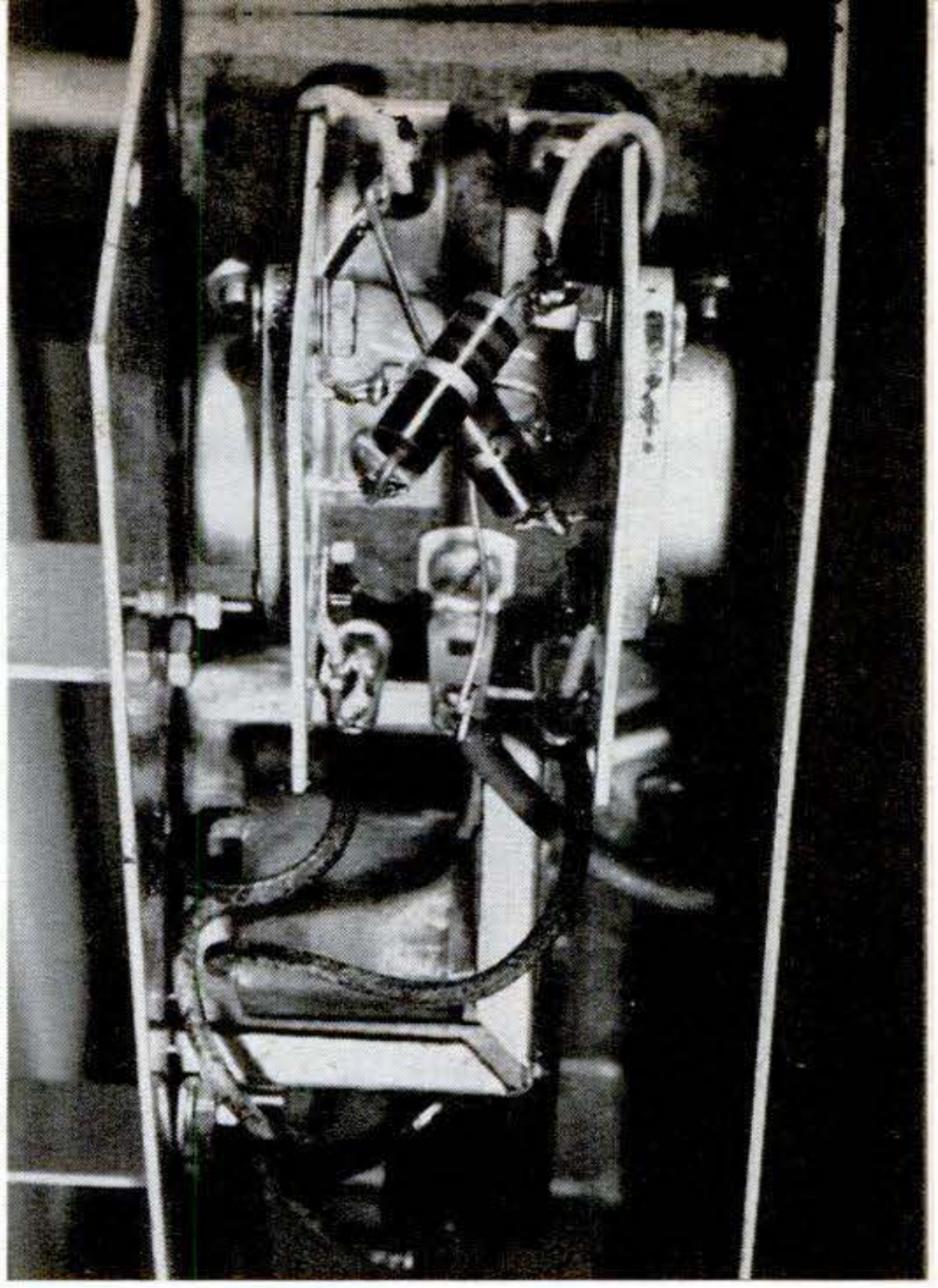
The trigger coil consists of three turns of #40 bare wire wrapped around the flash tube. Position the wire so that it doesn't touch the end electrodes. The trigger lead from the timing light to the No. 1 spark plug can be ordinary primary ignition cable. For a more flexible lead you can substitute 25,000-volt-insulation *cathode-ray-tube cable,* available from most larger electronic houses.

Make the positive and negative power leads, which run to the car battery, different colors to avoid confusion. The transistors will be damaged if the unit is hooked up backwards.

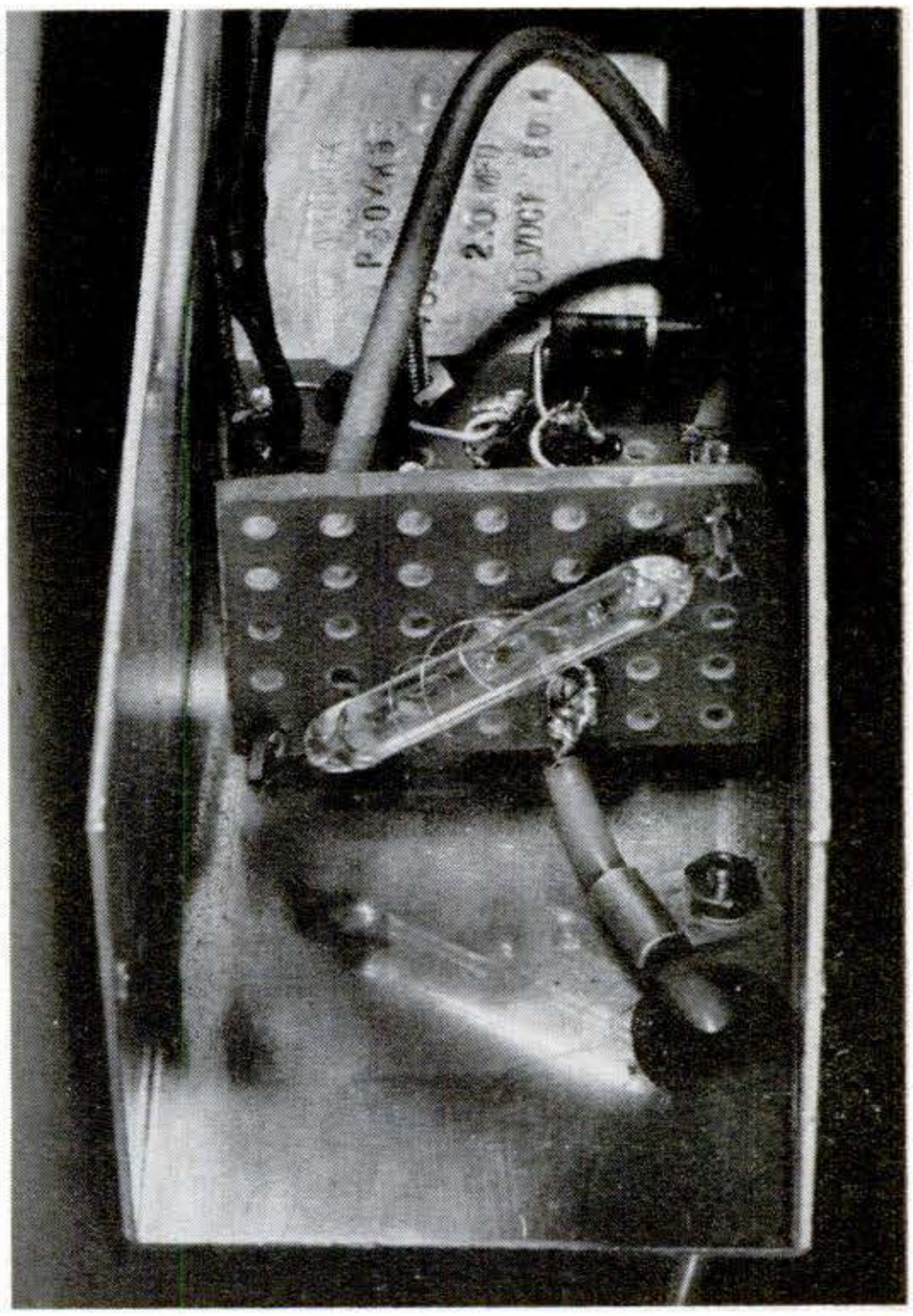
As a finishing touch, add two brackets made from scrap aluminum to hold the connecting cables when the unit is not in use.

Using the timing light. Use the xenon timing light as you would a neon unit, but without the darkroom techniques. Just connect the power leads to the car's battery, fasten the trigger lead to the No. 1 spark plug, point the timing light, and pull the trigger. If your car has a spark-plug connector of the enclosed type, you can make an adapter to fit between the plug and connector out of an 8-32 bolt and some old ignition fittings.

The timing light will work on both 6- and 12-volt systems. However, the light output at 6 volts will be noticeably less than on 12 volts. ■ ■



Power transistors must be mounted on the heat sinks. Make the two L-shaped mounts, shown here from above, of heavy-gauge aluminum sheet. The transistors are on the outer faces.



Flash tube, mounted as shown above, should be positioned at the focal point of the lens used. Fine wire around the tube is the trigger coil, which is connected to the No. 1 spark plug.

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Personal-use report

GE's 11-inch Personal TV

By Hubert Luckett

PORTABLE TVs for one-man viewing may stage a comeback with the introduction of this set. It's both light (12¾ pounds) and compact (about 10″ high and deep). GE seems to have licked the problems that plagued earlier attempts by U. S. makers to market personal sets.

I have been using one for about two months—in my workshop, office, bedroom, study, or out on the patio. Where I go, it goes, easily and conveniently any time there is a special program I don't want to miss. The picture is sharp, with plenty of contrast and brightness for viewing outdoors in the open shade. I get a good picture 25 miles from the transmitter, using the built-in antenna.

The only visible difference in performance from that of a first-rate, full-size set is slightly less definition of fine detail, and slightly more susceptibility to local interference. Price: $99.95.

Transistor ignition system is easy to install, cuts out at your option

No adjustment of components in conventional car ignitions is needed with this all-transistor system. A quick-disconnect plug lets you switch to either system.

As with all good transistor systems, you'll stretch tune-up periods, improve cold-weather starting, and, in most cars, get slightly better acceleration and gas mileage. The TI-1, made by Motion, Inc., 630 W. Mt. Pleasant Ave., Livingston, N.J., costs $59.95.

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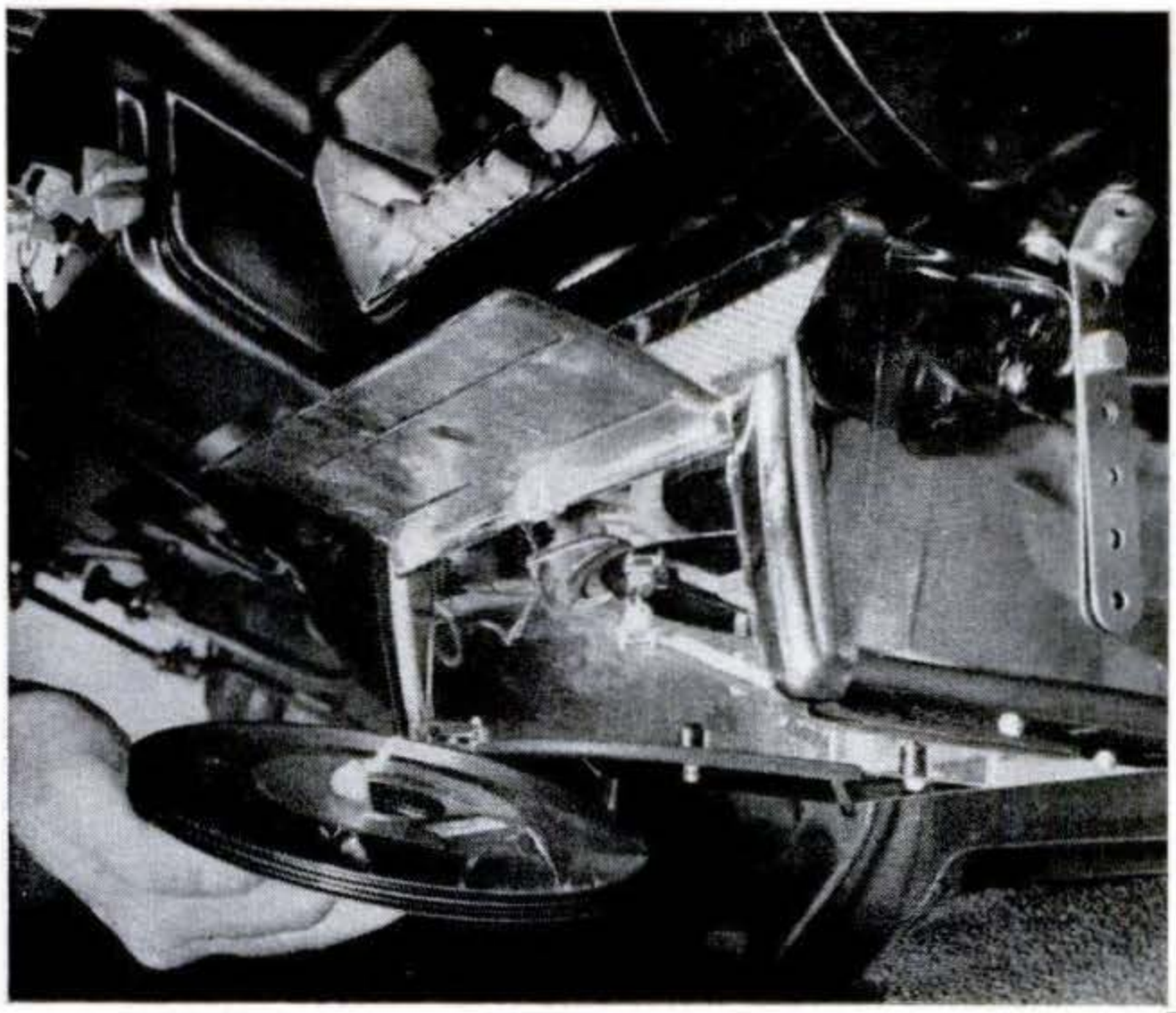

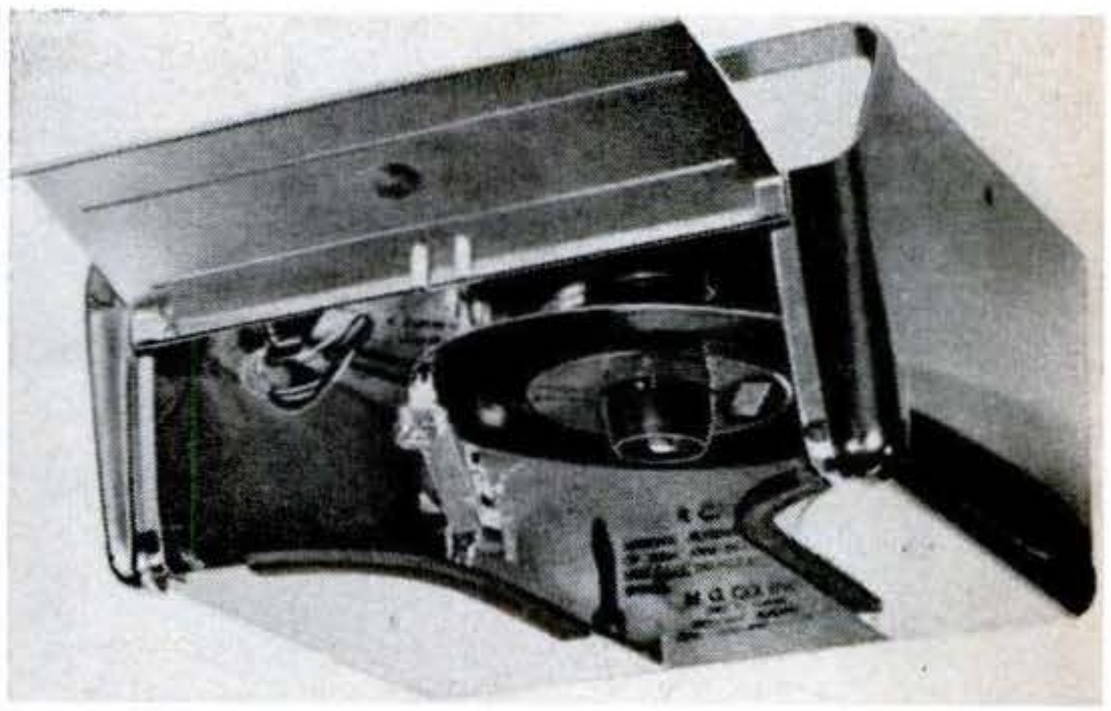

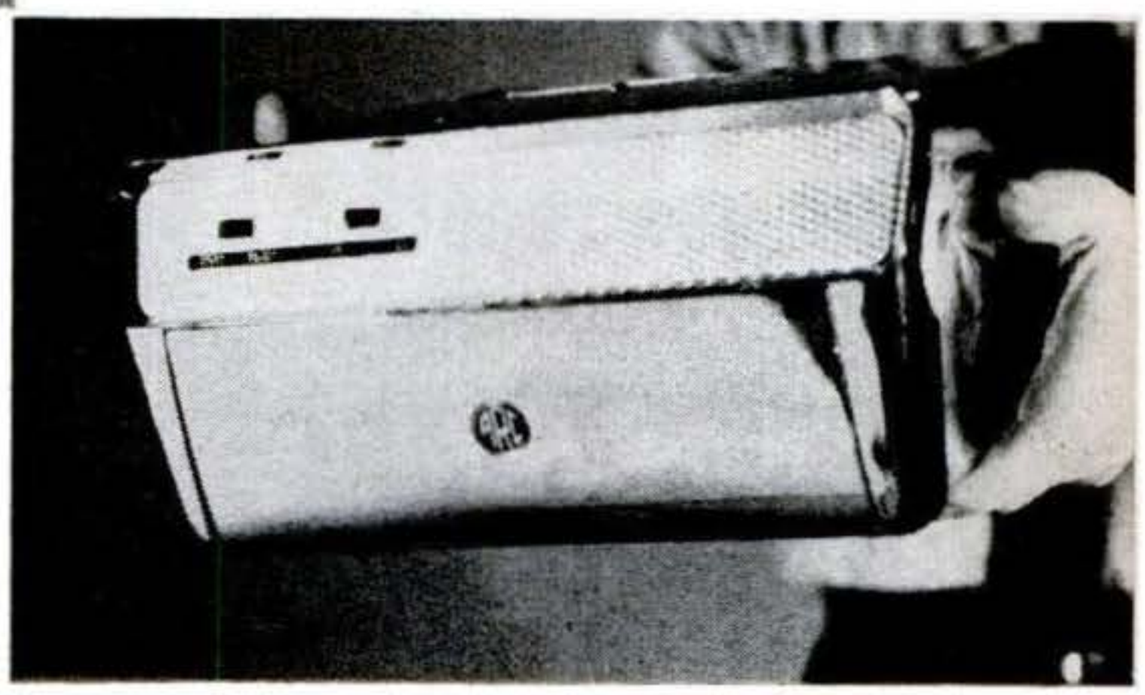

Personal-use report

Record Player for Your Car

THIS automatic record changer mounts under the dashboard of your car and plays through the amplifier and speaker of your car radio. It comes with mounting brackets and a connector socket that must be mounted on your radio.

It took me about two hours to take out the radio, mount the connector and wire it, and install the record changer. Unless you are familiar with the insides of car radios, you'll probably want to get a radio repairman to install the socket for you (the instructions furnished are rather skimpy). The rest of the job is simple—just drill a couple of holes through the underside of the dash, bolt on the brackets, and plug the connecting cable into the previously installed socket.

The changer will play up to 14 standard 45-r.p.m. records completely automatically—but not other sizes or speeds.

The unit is shock-mounted inside the 11½"-by-9"-by-6" case and plays without skipping on moderately bumpy roads, and when cornering or stopping. You can make it jump a groove if you try, but your passengers would probably complain before the record player would. A.R.C. Electronics, Inc., 13605 S. Paramount Blvd., South Gate, Calif., $99.95.—*Hubert Luckett.*

Flashlight gives ultraviolet light

A two-watt gaseous ultraviolet bulb powered by three "D" cells and a transistor inverter gives maximum light in the long-wavelength ultraviolet region. It's for mineral and biological studies, detection of check markings, inspection of textiles, dyes and inks, identification-badge checks and similar uses. $52. MED Electronics, Falls Church, Va.

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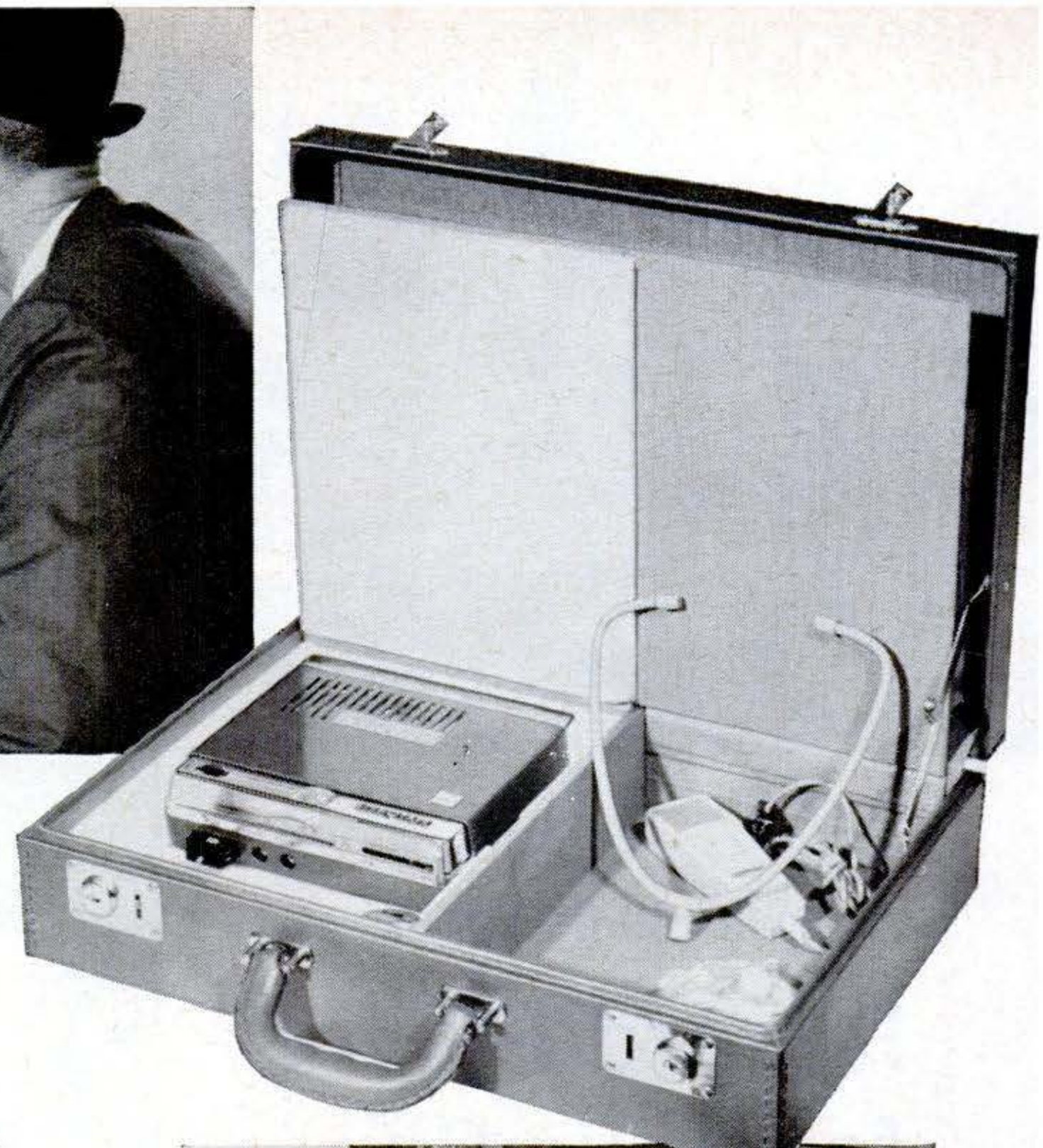

Personal-use report

Attaché Case Makes Secret Recordings

IT LOOKS like an ordinary attaché case, but with it you can unobtrusively capture up to two hours of conversation. A concealed microphone picks up sounds 20 feet away. You can start and stop the recorder without opening the case.

The cloak-and-dagger uses of the Stenotape TR-711 are obvious. But ordinary citizens will find it ideal for less romantic purposes: You can record interviews, take orders, or make candid "snapshots in sound" without giving your subjects mike fright.

With the case between the participants, as in the photo above, you get the clearest recording. But I found I could make perfectly intelligible recordings with the case on the floor by my chair, recording everything that was said in a conference with four or five persons. The TR-711 is sold by American Gelso Electronics, 251 Park Ave. South, NYC. Price $264.95.—*Hubert Luckett.*

Recorder is a dictating machine when removed from case. It is powered by six pencells, and comes with microphone and earphone.

Low-priced transistor wrist radio

This matchbook-size radio uses two transistors and one diode, powered by two mercury cells. Turned on when you plug in the earphone, it gives clear reception of local AM stations. Batteries last roughly 100 hours, cost about 35 cents each. Price: $6.95. Technical Marketing, 2124 Sepulveda, Los Angeles.

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PHOTOGRAPHICALLY SPEAKING

By Bob Hering PS PHOTO EDITOR

Huge, flawless "lens" made for atomic work

The partially polished optical glass window (shown at left below) was so heavy that it wasn't allowed on the floor of the German Photokina exhibit hall. Until recently such huge discs of optical glass were impractical. But a window, completely free from distortion, was needed to photograph atomic particle traces at the European Atomic Research Center in Geneva. The disc is 30 inches in diameter, 34 inches high, and weighs 2,160 lbs.

Books for your photographic library

Two photography books caught my eye this month. From the technical photographic director of Look Magazine, Arthur Rothstein, comes an authoritative book, *Creative Color* (Chilton Books, $2.95). It's written in a clear, understandable style and discusses useful ideas that will help raise your work to a higher creative level. The book can be a valuable guide for those wanting to get more than just an image on film.

If you have a yen to see Europe, or if you're a stay-at-home traveler, you'll enjoy Fritz Henle's new picture book, *Holiday in Europe* (The Viking Press, $8.50). The text by Anne Fremantle briefly describes the countries illustrated. Fritz Henle's well-composed color and black-and-white photographs use to advantage interesting foregrounds, unusual angles, and architectural details—giving them a graphic quality and freshness of style. Most of the pictures were made with Rolleiflex cameras; a few were shot with Plaubel Veriwide 100.

Now: Five new 35mm color films.

Ansco has four new films: Anscochrome 50, 100, and 200 (daylight), and T/100 (tungsten), numbered according to film speeds, have been beefed up considerably to meet the American preference for more vivid, saturated colors. In the samples I tested, the pinkish cast, characteristic of the old Super Anscochrome, was gone. Of the new Ansco emulsions, I particularly liked Anscochrome 200 for its good natural color rendition. Anscochrome 100 and 200 daylight were especially good at recording neutral tones—clean grays and whites.

An improved Perutz daylight color film is now available. Called Peruchrome, its color rendition is far better than the film it replaces. Instead of the greenish tinge noted in older film, there's a shift to a warmer color balance. It has good color saturation over the full range, with snap and brilliance.

Unique feature: Processed films are sent back in durable plastic mounts which unsnap. Three regional color laboratories will handle the work. Film prices include processing.

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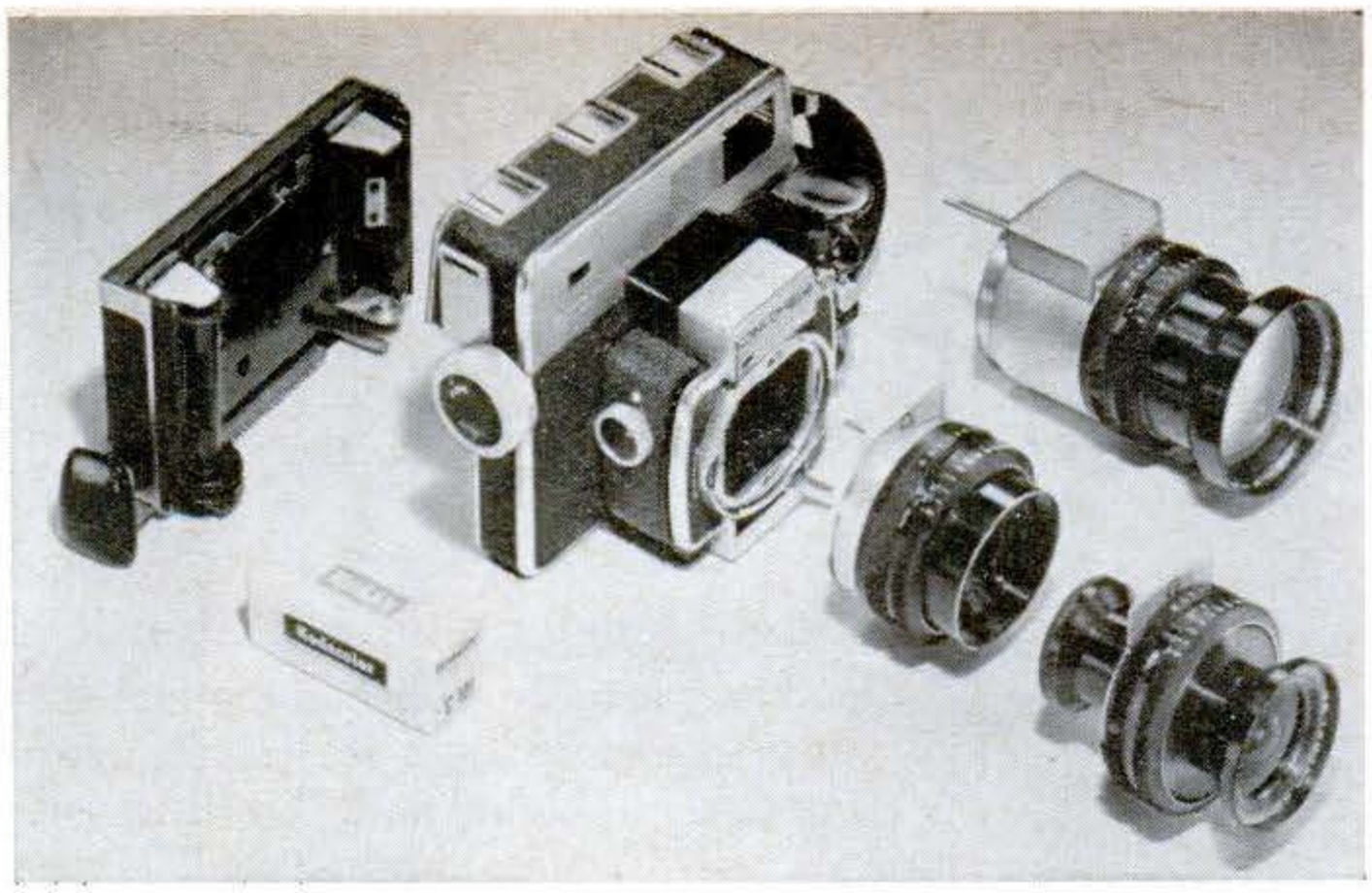
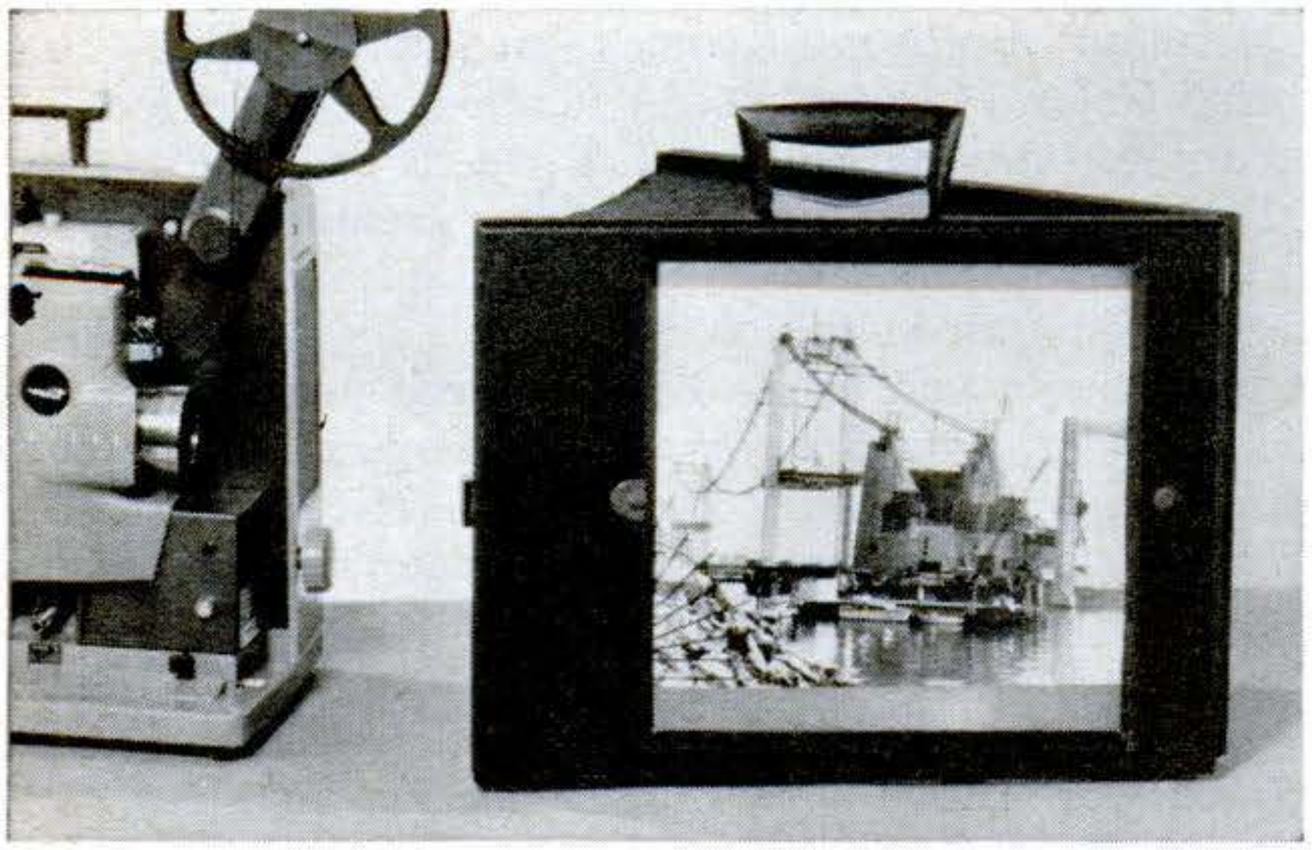


New camera for fast, continuous shooting

A camera for advanced amateurs and professionals, the Koni/Omega takes on film preloaded into interchangeable backs. It makes 10 exposures, 2¼ by 2¾ on 120 film. A fast push-pull film transport simultaneously cocks the shutter, and three lenses couple to the range-viewfinder. About $350. Simmon Omega, Inc., NYC.

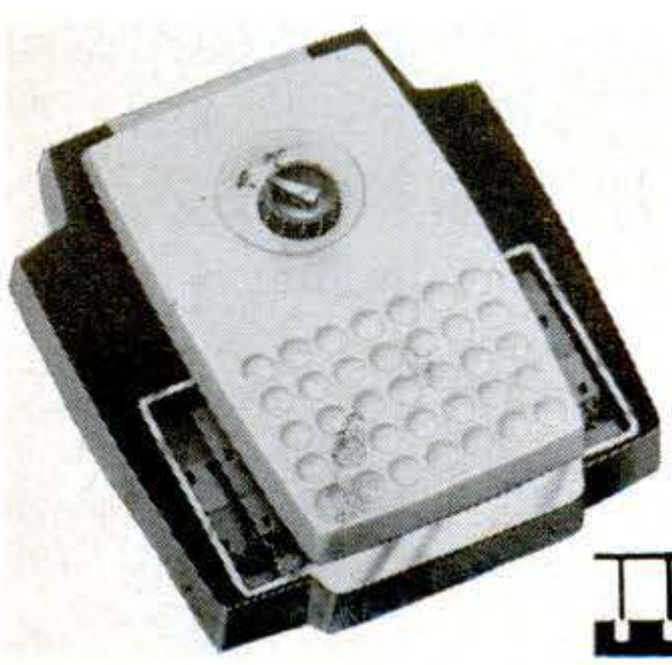


Rear-projection screen opens like a book

This compact rear-projection screen folds into an attaché-size case measuring 2¼″ by 18″ by 13¼″. The screen is large enough (12″ by 12″) to be seen by groups of up to 20 persons, and can be used under any light conditions—even daylight. Price: about $50. Hudson Photo Industries, Irvington-on-Hudson, N.Y.

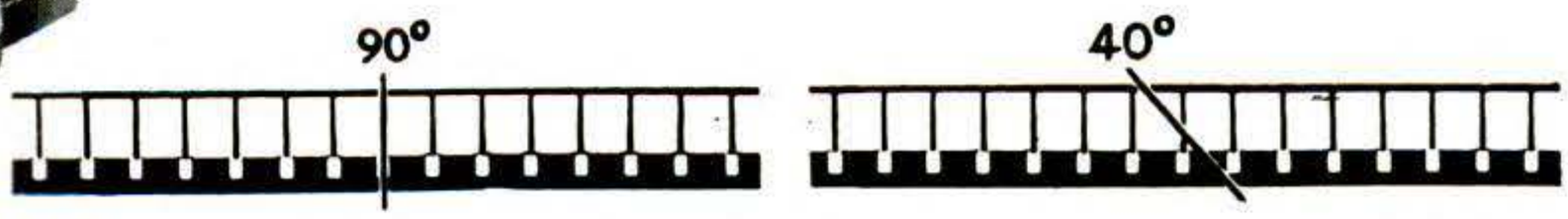
Easy-focusing monocular

Focusing is easier with this new monocular—instead of turning the entire monocular, you turn only the calibrated ring on the front. Designed for use on 35mm single-lens reflex cameras, it provides 8-power magnification. The unit is 3½″ long, weighs but 7 ounces. Price of the 8x30: $99. Carl Zeiss, Inc., NYC.



Film splicer features adjustable cutting angle

With this 8mm splicer, you can preselect the cutting angle. Use a 90-degree cut for a splice that's invisible when projected. Change to a 40-degree cut if the projector tends to chatter or lose loop. Adjusta-Cut splicer is $2.98. Hudson Photo Industries, Irvington-on-Hudson, N.Y.



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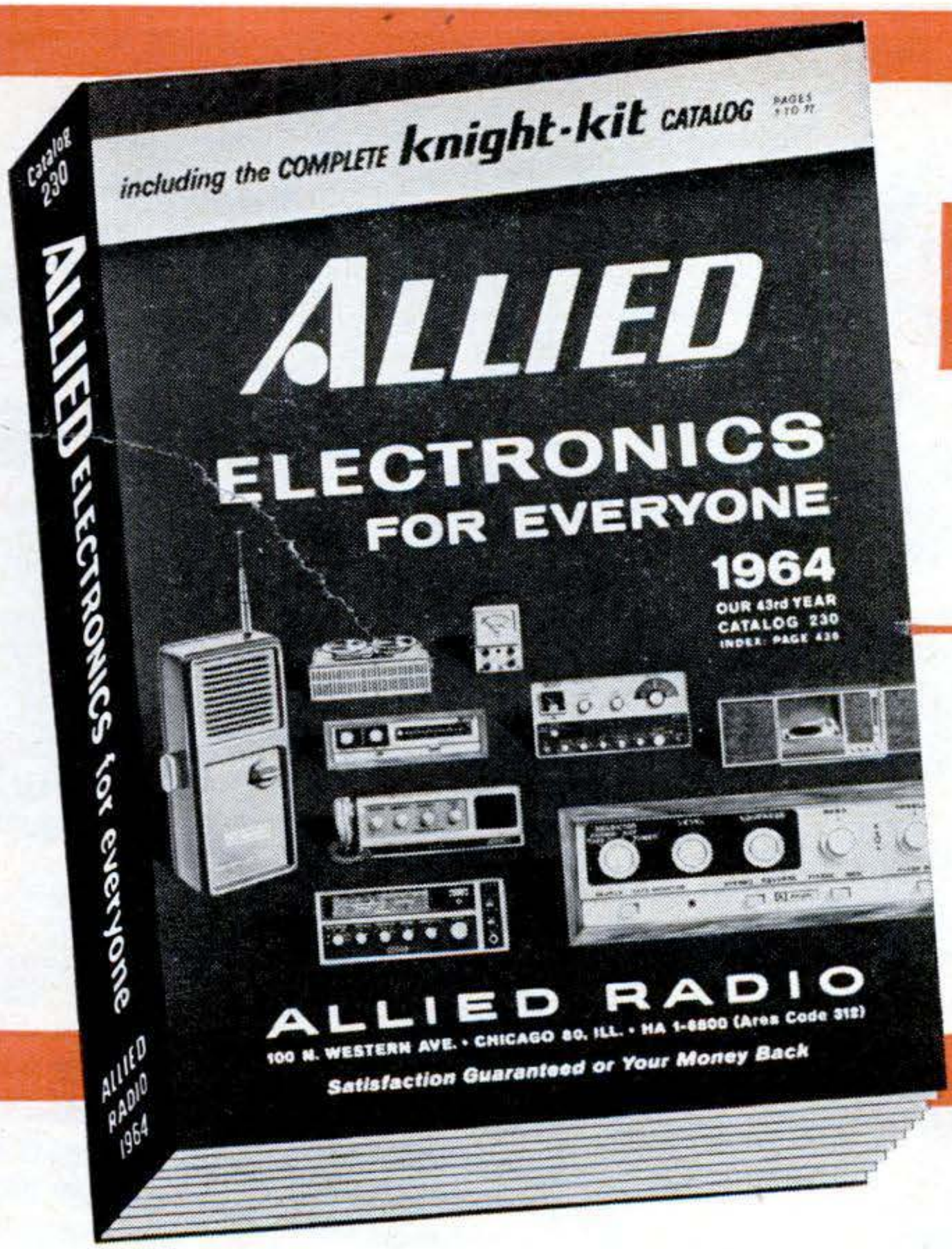

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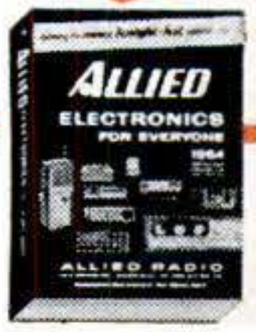

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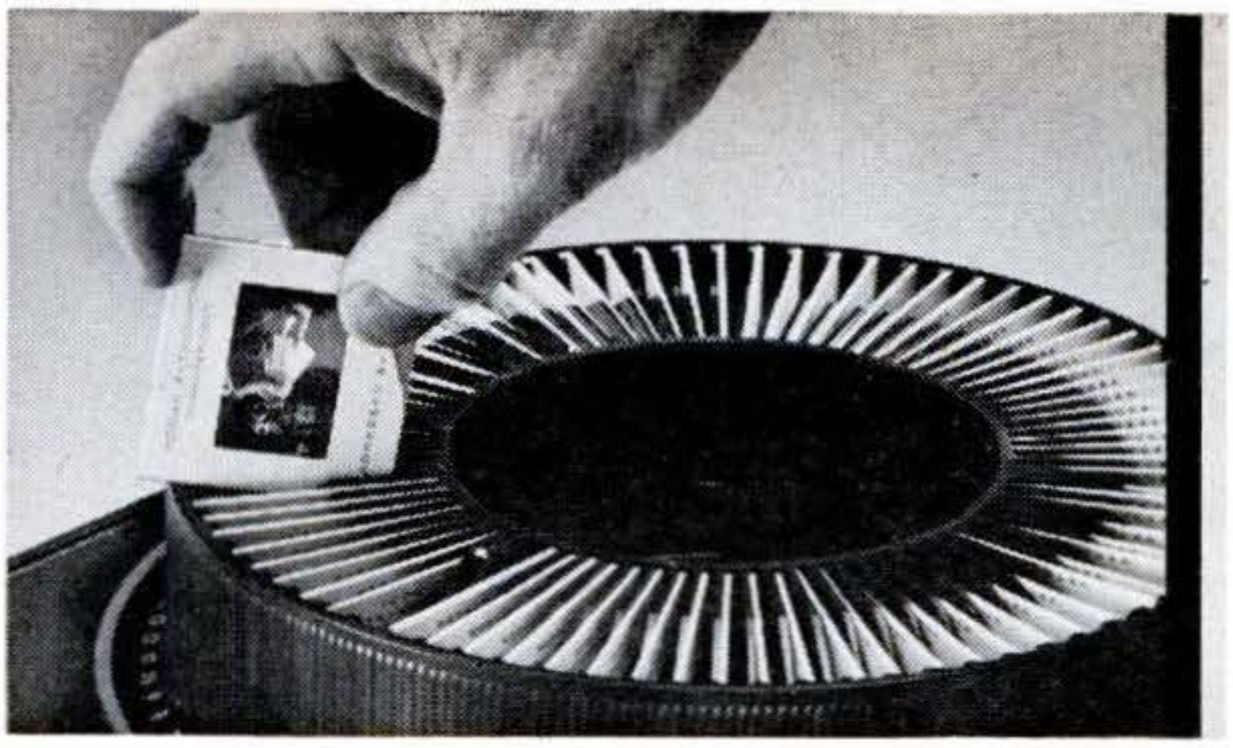
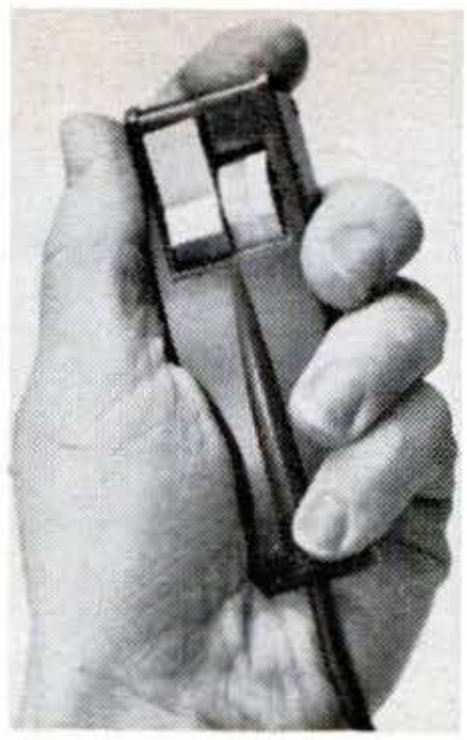
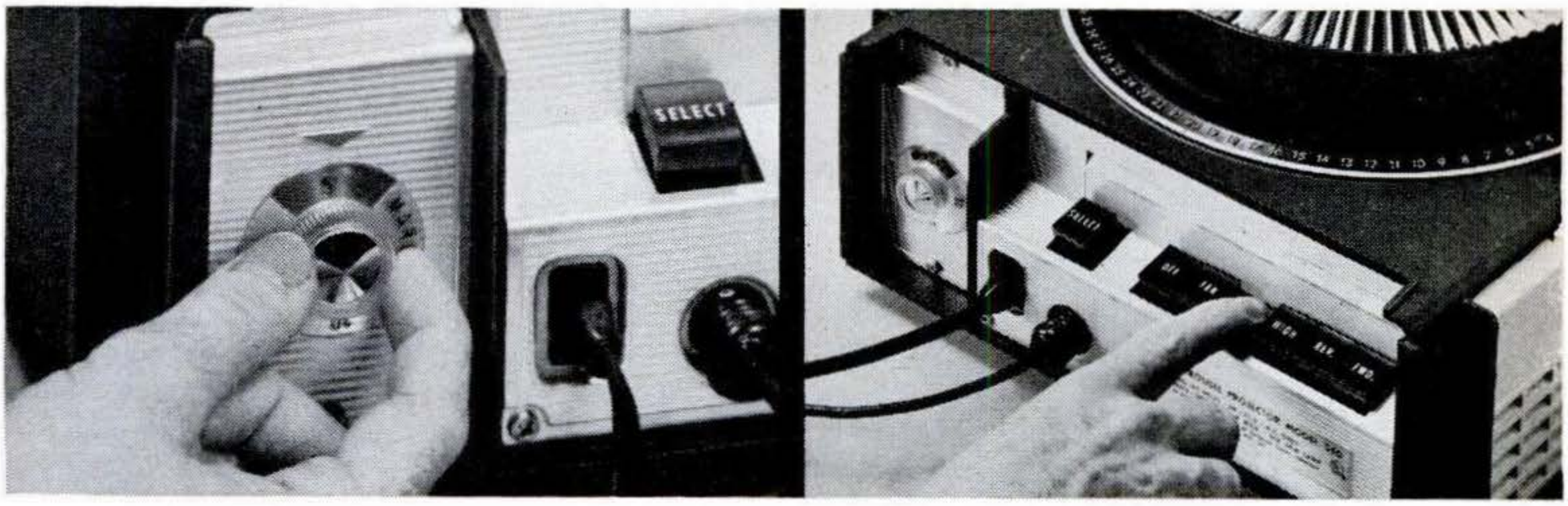


80 SLIDES are quickly loaded and locked in the round tray—no special mounts needed. All slides are within editing reach throughout the show. Tray stores like a book on a shelf.



REMOTE CONTROL lets you sit back and run the show with one finger. A touch makes slides go forward or back, as fast or as slowly as you want. Even lets you fine-tune the focus!



AUTOMATIC TIMER puts on a completely automatic show at slide-changing intervals of 5, 10 or 20 seconds. Just set it . . . and sit back. Permits continuous operation for exhibits.

KEYBOARD CONSOLE centralizes push buttons for forward, reverse, high-low lamp brilliance. "Select" button lets you spin tray to any slide for viewing or easy editing.

master showman automatically

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Why not enjoy this professional slide-show smoothness and efficiency in your living room soon! See the KODAK CAROUSEL Projector at your Kodak dealer's. With one tray and a 3-, 4-, or 5-inch *f*/3.5 lens, less than $150; with zoom lens, less than $180.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

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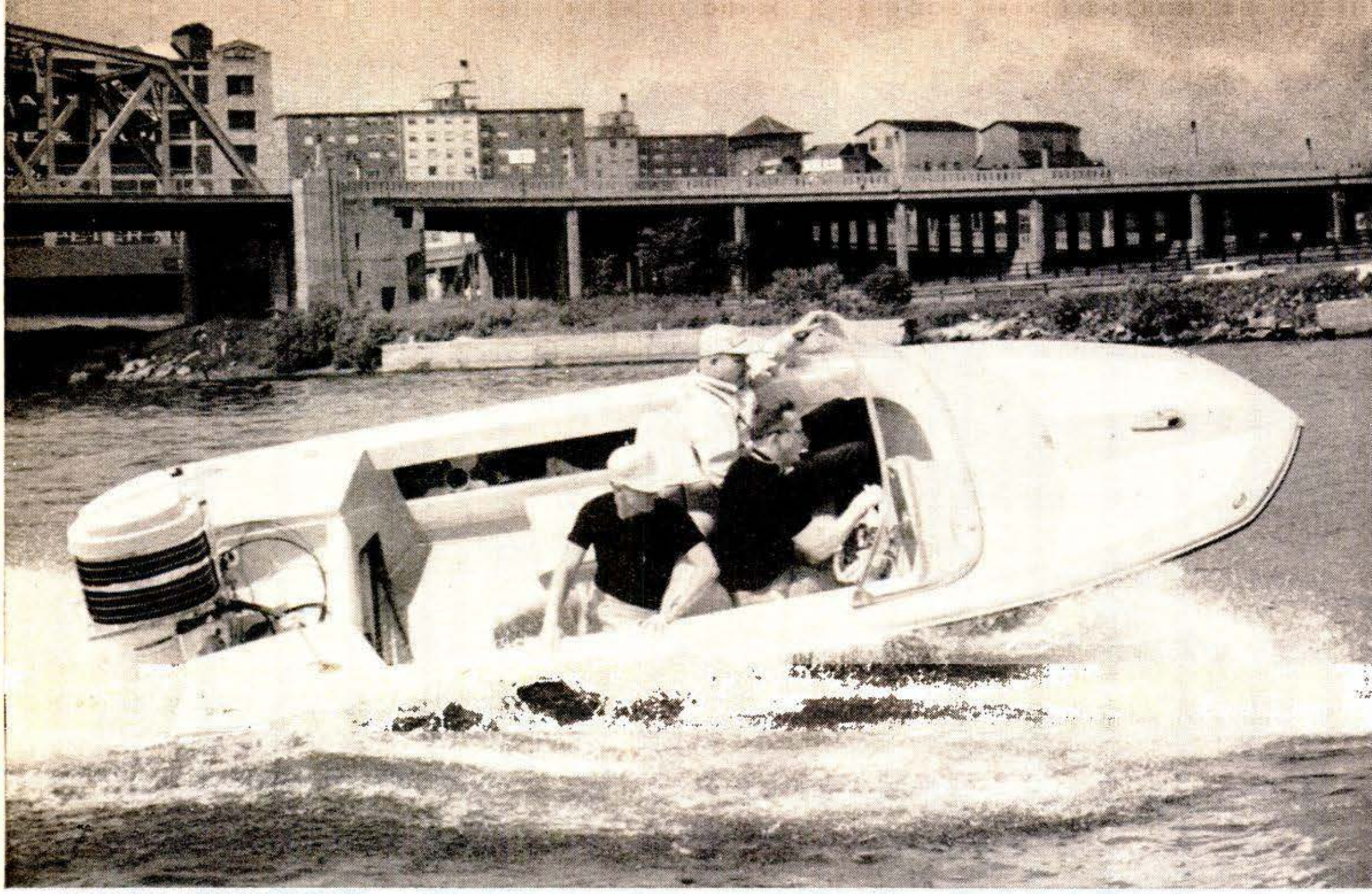

PHOTOS BY HARRIET ARNOLD

Jim Roe Tests the Glastron Futura

In the wake of the exciting Albany-New York race, this sturdy runabout proved she can take it

By Jim Roe

THE boat that won the recent 134-mile dash down the Hudson River from Albany to New York did it because it had guts. While other boats were taking a slower roundabout course near shore to avoid rough water, the winning craft, a sleek 17-foot Glastron Sportsman, was blazing straight through the river's wildest stretch to beat 74 rivals home.

It was not by coincidence that we chose the day of the Hudson River Marathon to test out an even newer Glastron, the V-150 Futura. We wanted to put this slightly smaller sister of the winner through some of the same race-course conditions.

The Futura is 15 feet of all-fiberglass ruggedness, incorporating the same deep-V hull as its bigger sister, and capable of handling outboard motors of up to 85 hp. Chances are, you haven't seen it yet for it was just unwrapped in late September at Chicago's big Marine Trades Exhibit and Conference. We were able to get an early hull in time for the June Marathon. It was not entered in the race because it

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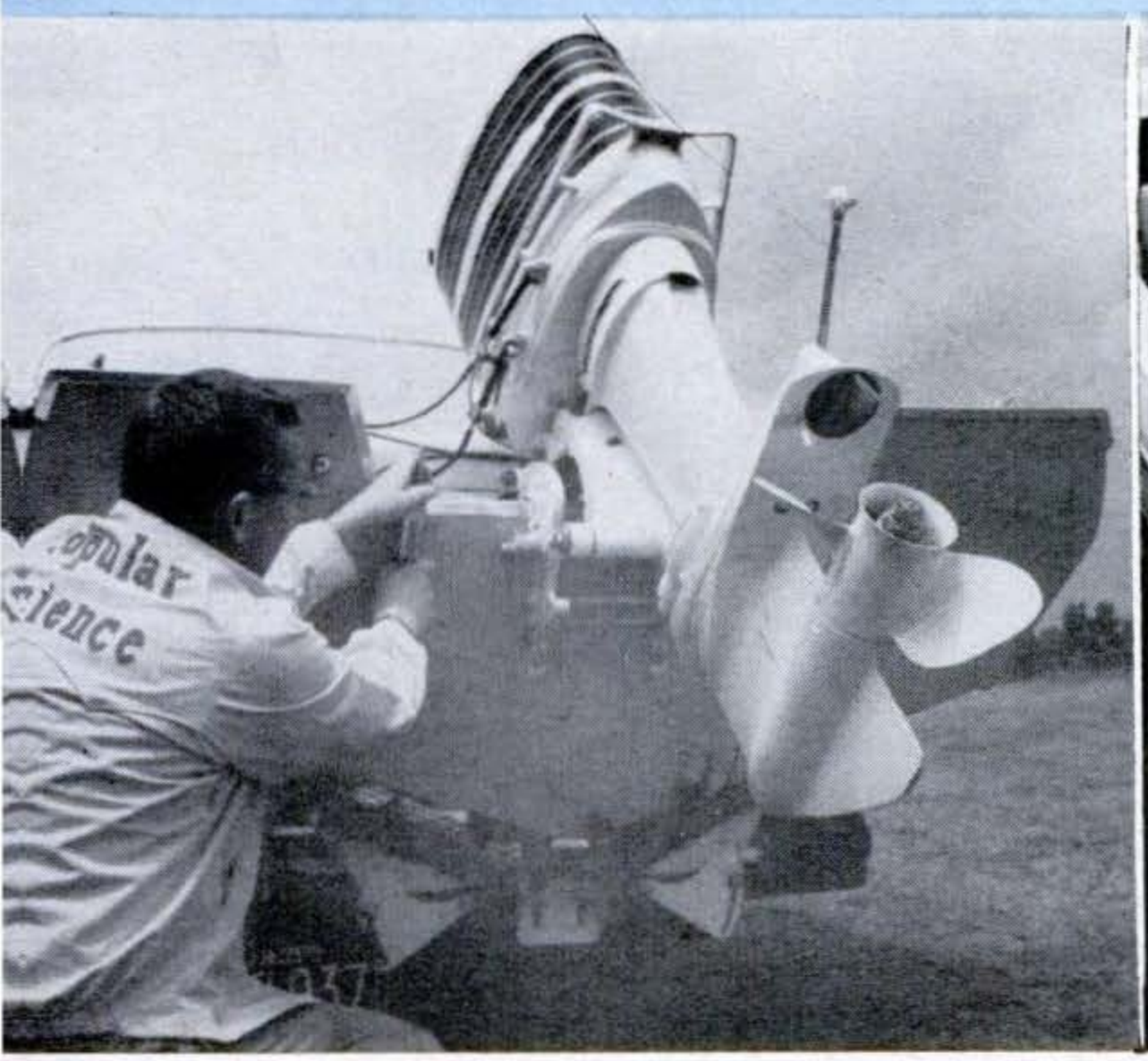
In hard turns or flat out, the Futura kept us high and dry. Even in steep banks, as at left, no spray came in on us because chine rails along the sides direct wave-splash downward.

What We're Testing

Name: Glastron V-150 Futura
Centerline length: 15′
Beam forward: 72″
Beam transom: 67″
Max. depth: 36″
Transom height: 20½″
Approx. weight: 580 lb.
Max. rec. hp. (OBC): 85
Load capacity: 1,150 lb.
Hull material: fiberglass
Standard equipment: built-in lighting; pulley steering system; tilting windshield; one back-to-back seat, one convertible sleeper seat.

Deep-V hull design carries all the way to the stern, making the Futura unusually stable in rough water. This 85-hp. Mercury made a perfect companion, giving us speeds to 36 m.p.h.

Inboard-outboard version of the Futura sports an 80-hp. Volvo outdrive, with 110 horses optional. Engine nestles neatly under a sound-padded swing-up cowl, gives 40-m.p.h. speeds.



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Tandem-wheeled trailer proved a big help in getting our test boat into and out of the Hudson. Note the long rows of rollers on this Ship-Mate model that ease the hull on and off.

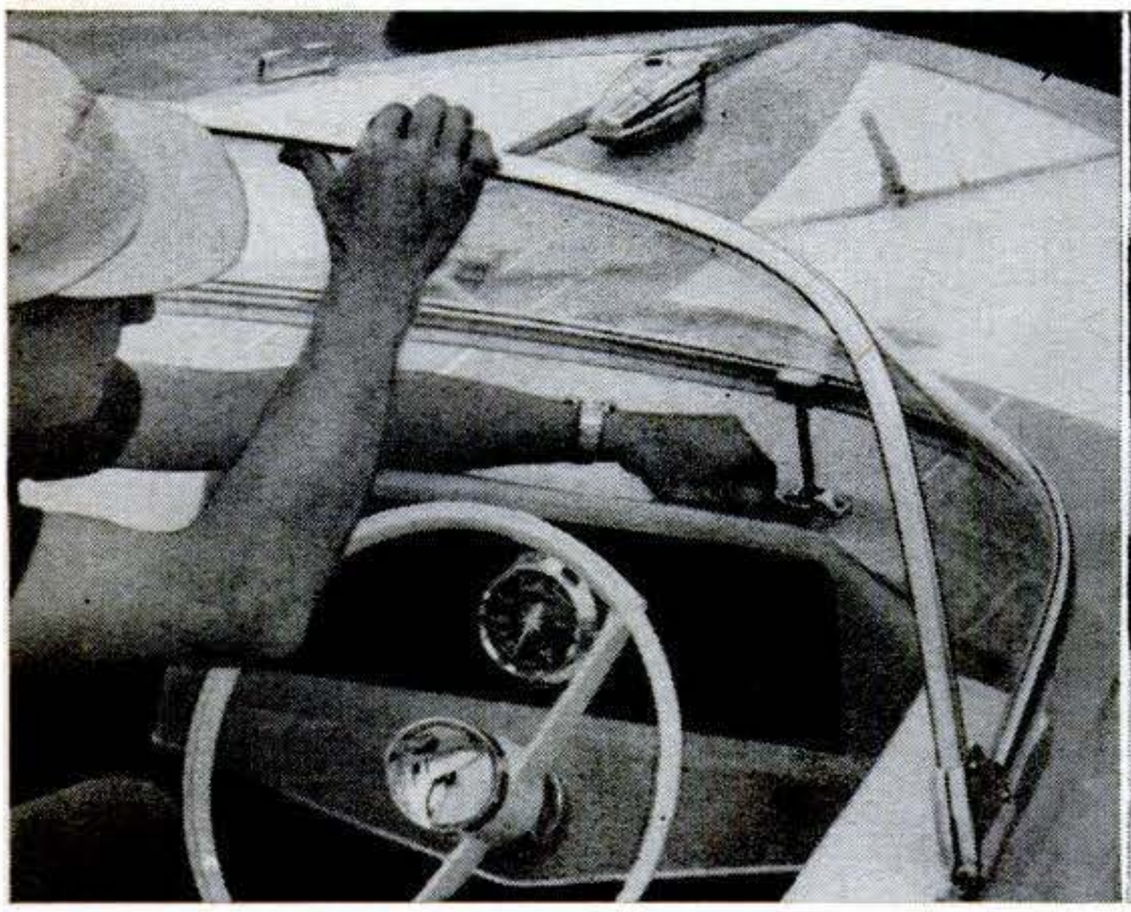
was too new to be classed as a stock outboard, a race requirement.

Deep-V hull. The Futura is one of the smallest boats you can get with a full deep-V hull—a design that has proven itself in rough water in race after race. We were eager to see if deep-V stability was as marked in a 15-footer as it is in larger craft.

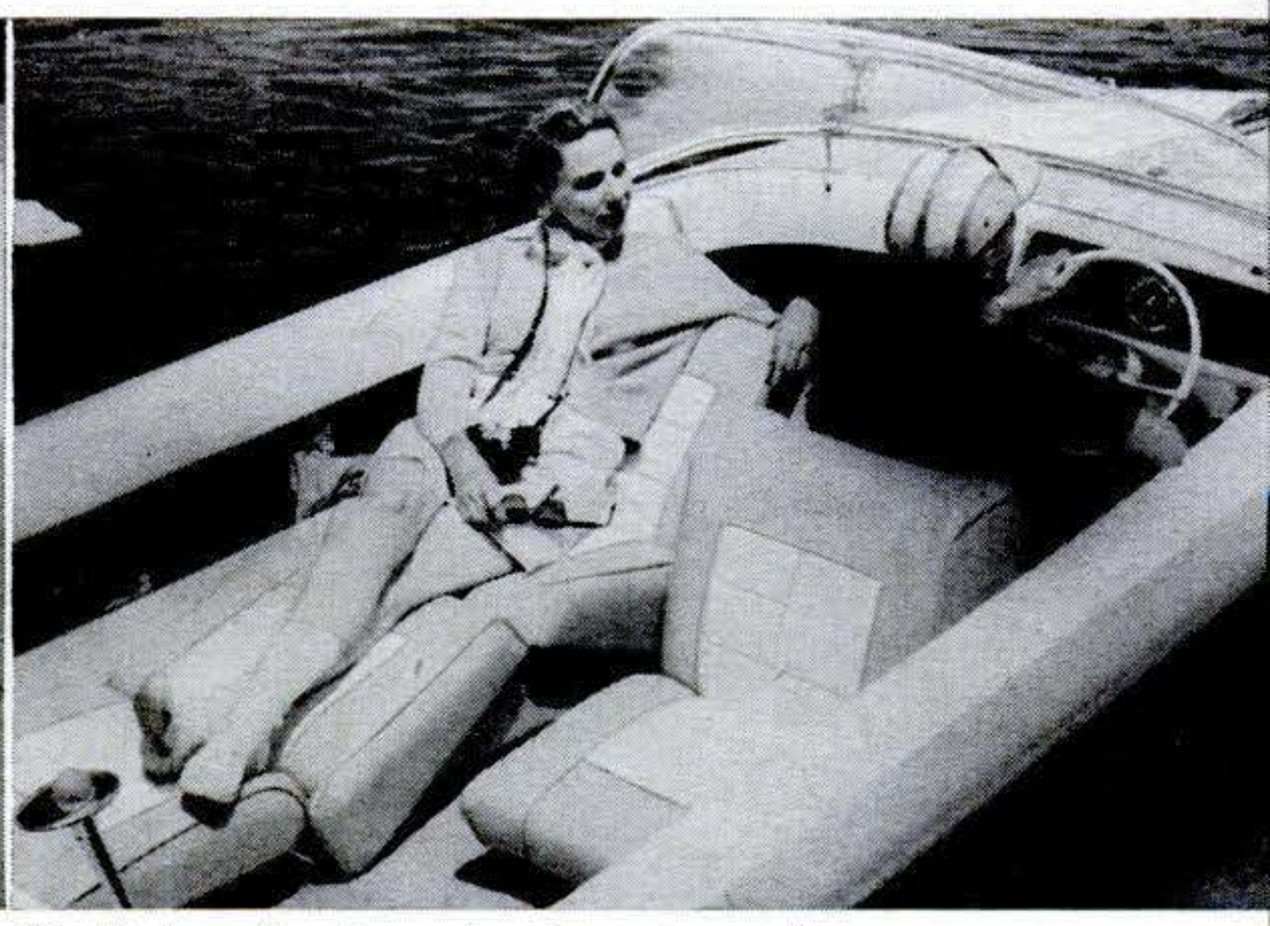
The Futura has a spray-control chine that throws the water out to the side and down, rather than up to wash your face. A wide flare at the bow helps accomplish the same thing in a following sea and gives the bow a positive buoyancy in heavy seas of three feet or more.

The result is a small, attractive, capable, and tough boat—ideal, I'd say, as a family runabout or ski boat. It's not only easy to handle and fun on smooth water, but it gets you back home if you're caught out in rough weather.

Our test got off to a damp start. Rain was the order of the day on the Saturday before



Swing-up windshield can be partially raised on adjustable legs to let in breezes, as here, or can be tilted all the way back so you can walk right out on the deck from the driver's seat.



Reclining front seat gives tops in passenger comfort, as sampled here by Mary Crossley, Editor Bob Crossley's wife. It also folds up into two-way fore-and-aft seat like driver's.

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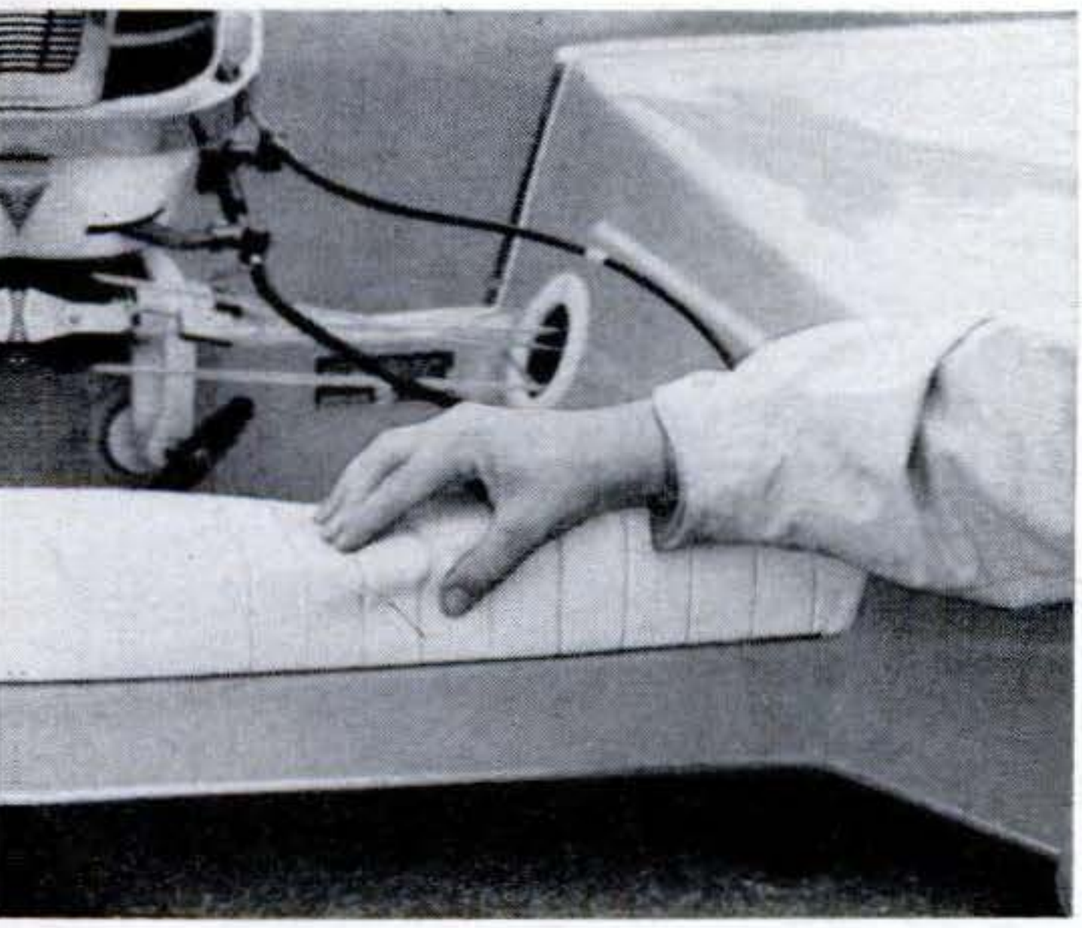
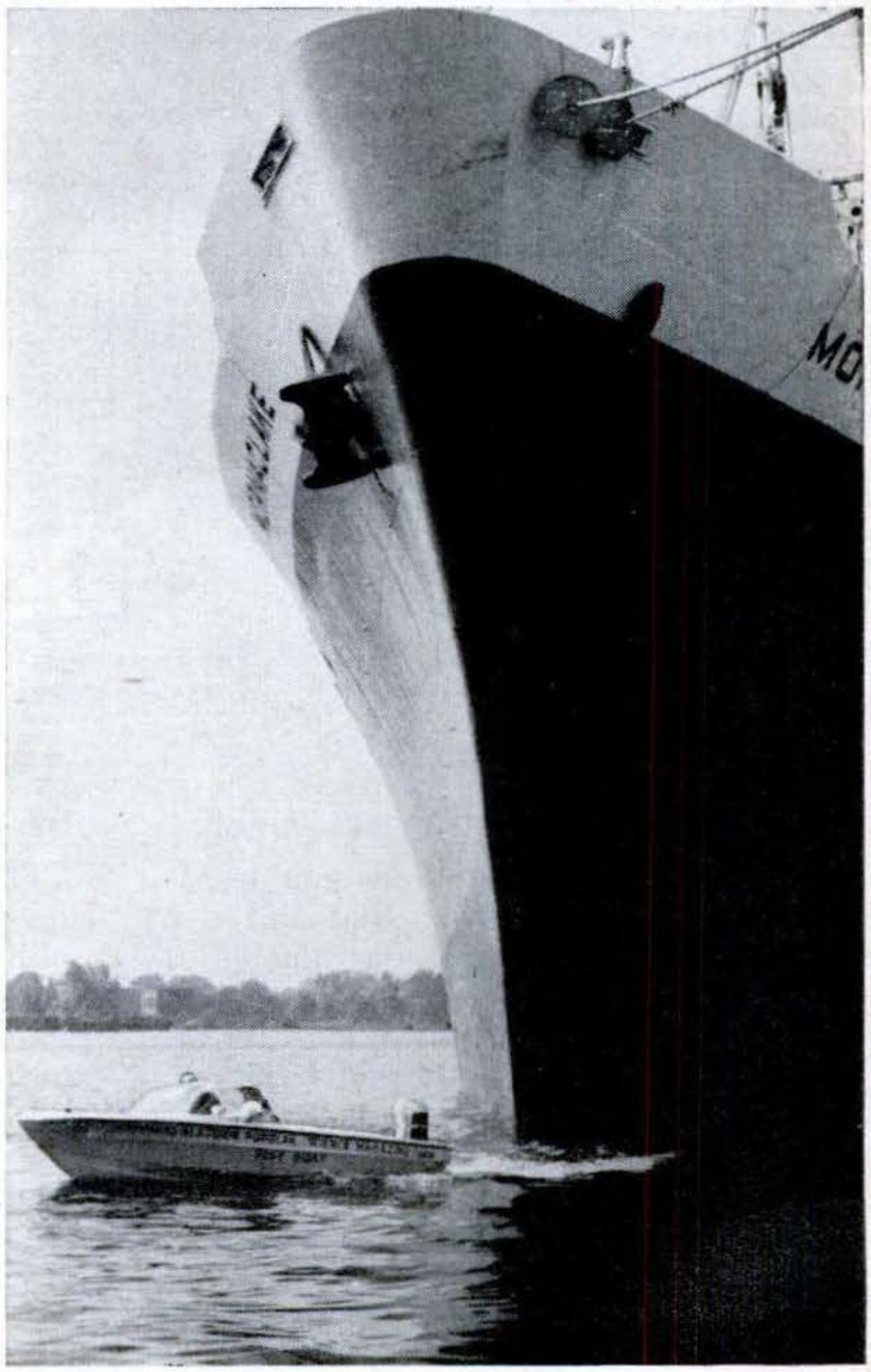
We watched the race boats take off before putting the Futura through tests. Playing tag with giant freighters like the one below was both fun and a workout for our scrappy little boat.

the race, as some 100 outboard rigs assembled at Albany. Our brand-new boat, trailered up from the Glastron plant in Austin, Tex., was delayed by tractor breakdowns. Consequently we were up at dawn to get her fueled and fitted out before the 9:00 a.m. race deadline. But getting the motor and controls rigged on time proved the boat can be readied for use easily.

[*Continued on page 202*]



Foam-padded transom is a touch of luxury you don't find on many boats. It comes in real handy when you have to lean out over it to reach the motor.



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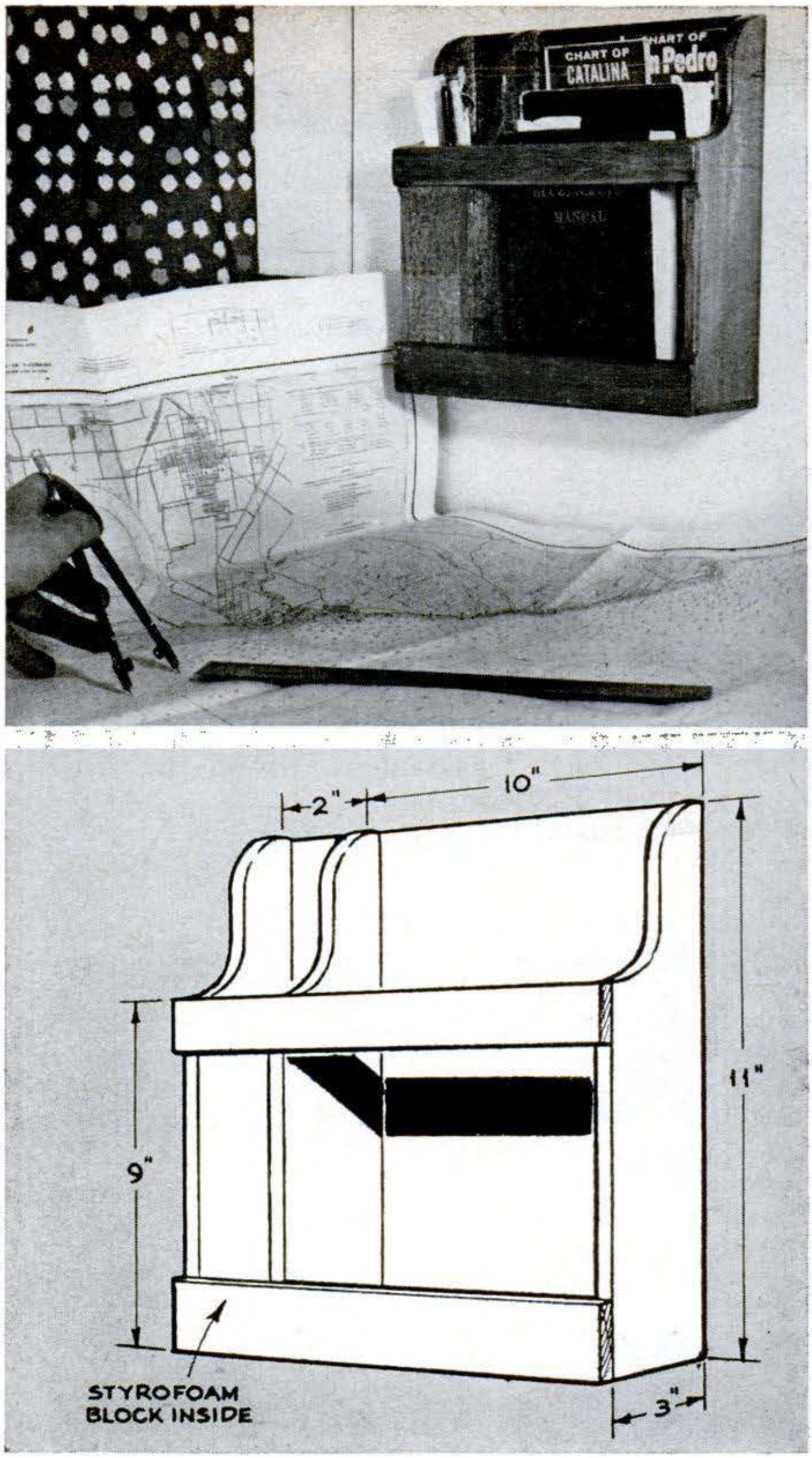
Short Cuts and Tips FROM PS READERS

Navigation aids store neatly in this boat rack

This mahogany wall rack holds all of a ship's navigation aids in one handy spot. Charts and manuals slip into one side, while a separate boxed-in section at the other side holds rulers, pencils, and dividers. A plastic block at the bottom cushions the points and keeps the tools uncluttered.

Buy solid, clear-grain mahogany and sand it down with fine paper. Attach the parts with a top grade of marine glue. Finishing nails will hold the parts fast while the glue dries. Set the nailheads and conceal them with mahogany wood filler. To add the final touch, stain the rack to match the boat's present wood finish and apply three or more coats of marine varnish for a lasting finish.—*Victor W. Kondra, Temple City, Calif.*



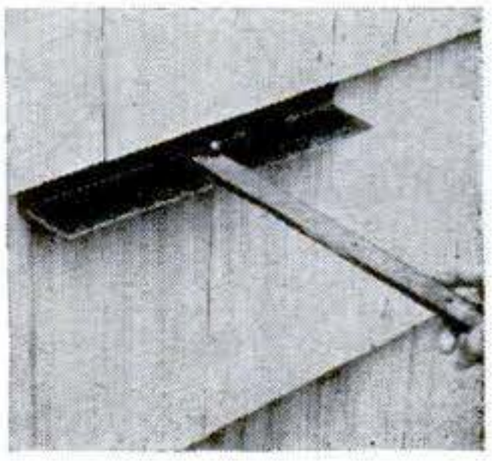
►►► A handy place to hang a litter bag is the handle of your power mower. It's just right for stashing sticks and other trash picked up as you mow.—*Jack Hirrlinger, College Park, Md.*

Solder lug made on an eyelet punch

When you need a solder lug and don't have one handy, try making one up this way. Wind the wire lead around the anvil of an eyelet punch. Squeezing the punch will crimp the wire coil into a neat eye.—*James H. Olsen, Ossining, N. Y.*

Pry bar removes shingles harmlessly

This L-shaped tool hooks under shingles and pries them loose with a minimum of splitting or breaking. Nails either come out with the shingles or pull through. The pry bar should measure out to the same width as one shingle. This will insure a clean break. Pipe or scrap iron makes a handle. —*W. O. Michaelis, Olympia, Wash.*



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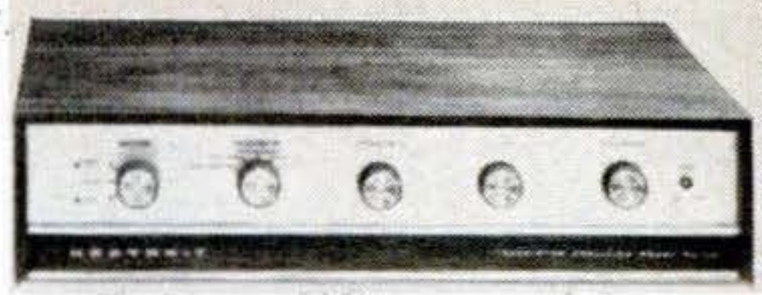
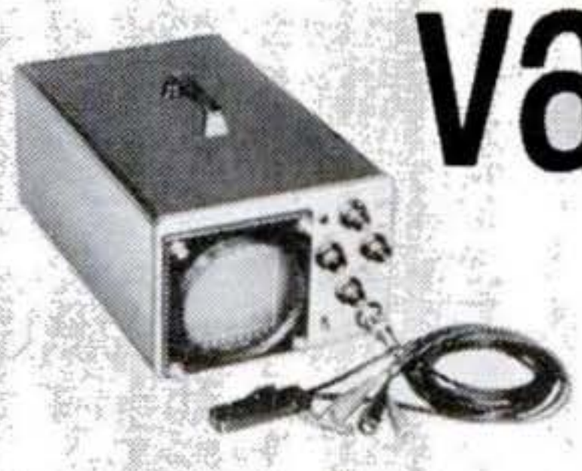
FOR HAM RADIO— Heathkit 80 Meter SSB Transceiver, Kit HW-12, $119.95.

FOR SPORTS — Heathkit 1-Watt Walkie Talkie, Kit GW-52, $74.95.



FOR STEREO/HI-FI—Heathkit 40-Watt All-Transistor Stereo Amplifier, Kit AA-22, $99.95.

Here are a few Heathkit values...



FOR YOUR BOAT— Heathkit 25-Watt Radiotelephone, Kit MWW-13, $164.95.

there are 245 more where these came from!

FOR YOUR CAR— Heathkit Ignition Analyzer, Kit IO-20, $89.95.

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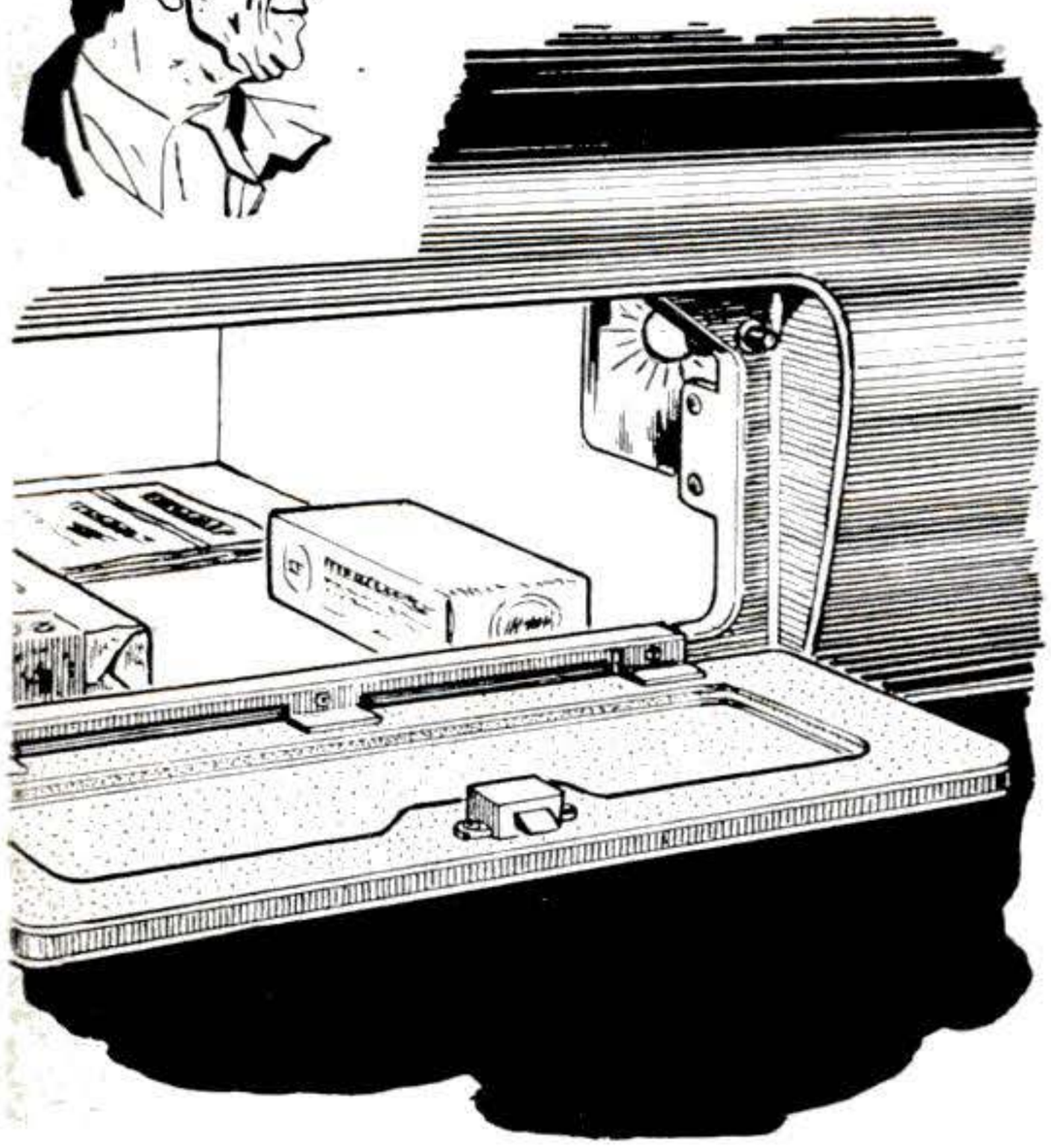
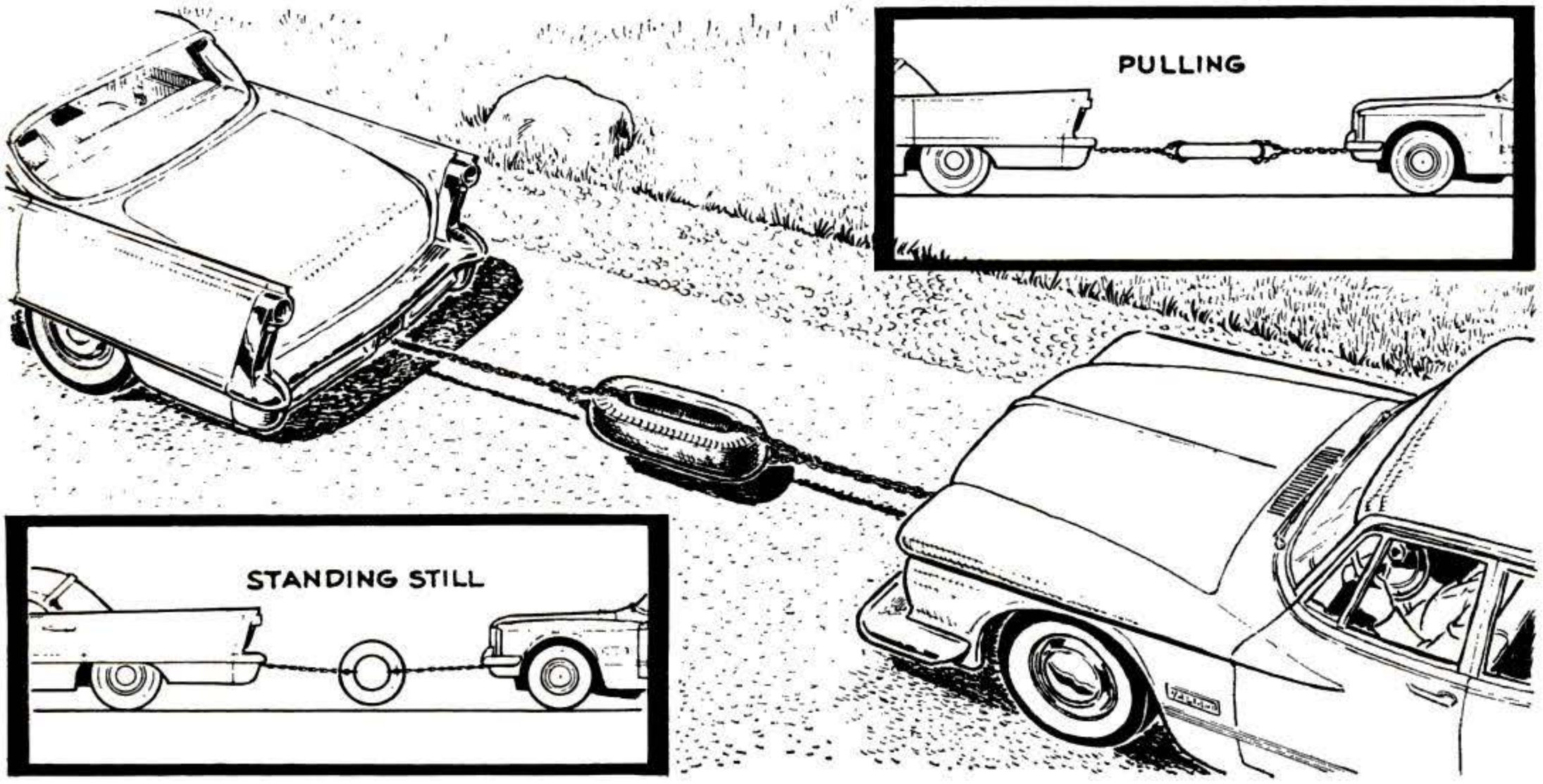
Hints from the Model Garage



You'll have more light in your glove box if you line the inside of the compartment with white polyurethane foam plastic and glue a small mirror behind the bulb. The foam lining also will reduce rattling of loose objects and help prevent breakage.

To prevent scratching fenders with belt buckles when leaning over to clean windshields, service-station men may want to try this hint: Wrap a small rag or handkerchief around the buckle; tuck the loose end inside the waistband so it won't slip.



When towing a car, bumpers take a beating. To take the strain off, use two lengths of chain and an old car tire in between. As the lead car begins to pull, the tire is stretched —often a foot or more—thus cushioning the initial jerk and preventing a bumper from being torn off. Make sure the chains are long enough so that the lead car isn't rammed if a fast stop is necessary. Also, flat towing is recommended only for short distances or to help a car to get started when bogged down in mud or stuck in snow.

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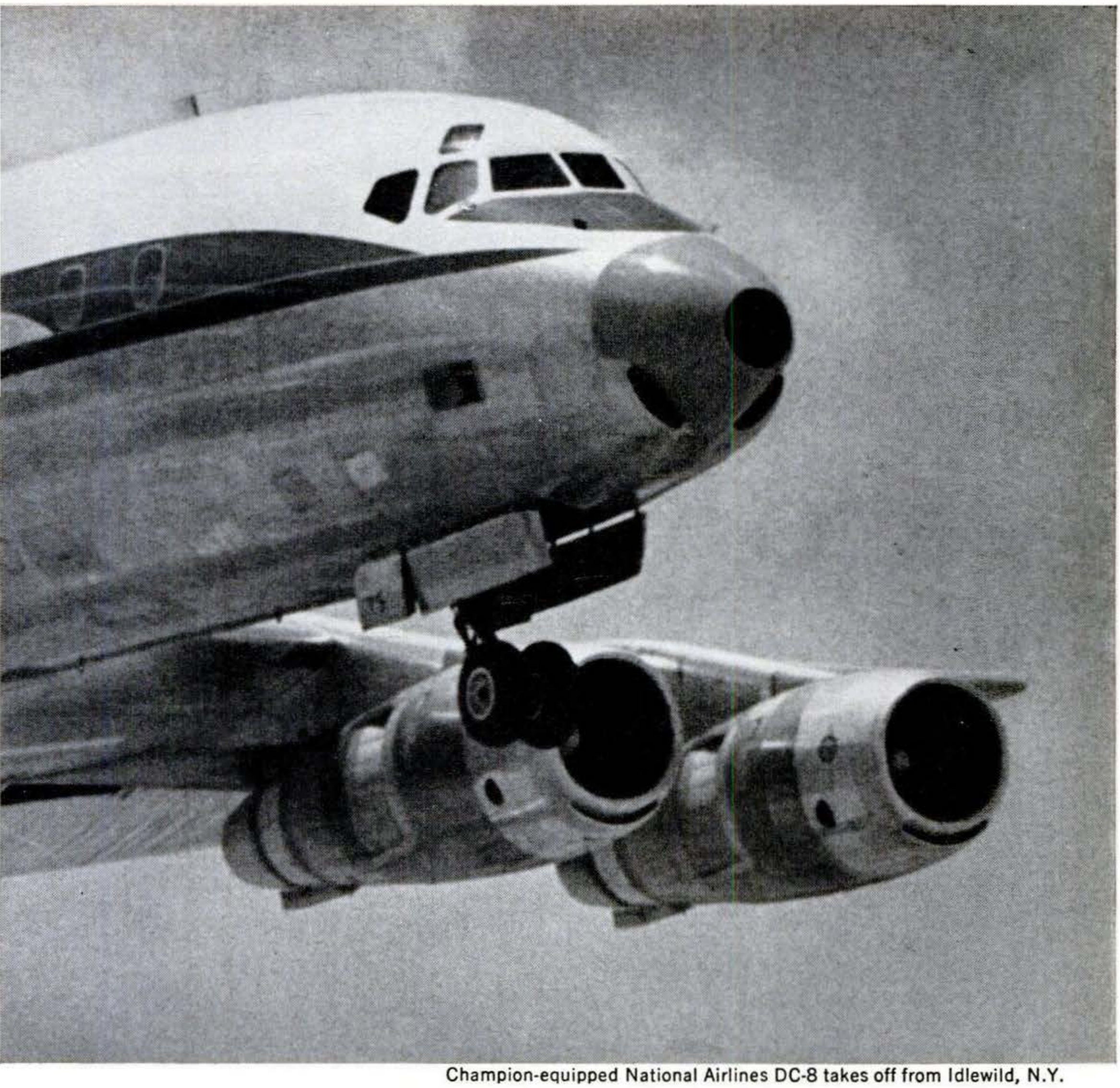

Champion-equipped National Airlines DC-8 takes off from Idlewild, N.Y.

Every major U.S. airline uses Champion spark plugs, or Champion jet igniters, because Champions deliver the utmost in dependability. Why settle for less in your car?

P.S. Here's the surest way to avoid starting trouble this winter. In testing thousands of cars last winter, worn spark plugs were the No. 1 cause of starting failures. In fact, cars with more than 10,000 miles on the plugs had three times more starting failures than cars with good plugs. So avoid a "no start" morning this winter. Install new Champions now!

DEPENDABLE
CHAMPION
SPARK PLUGS

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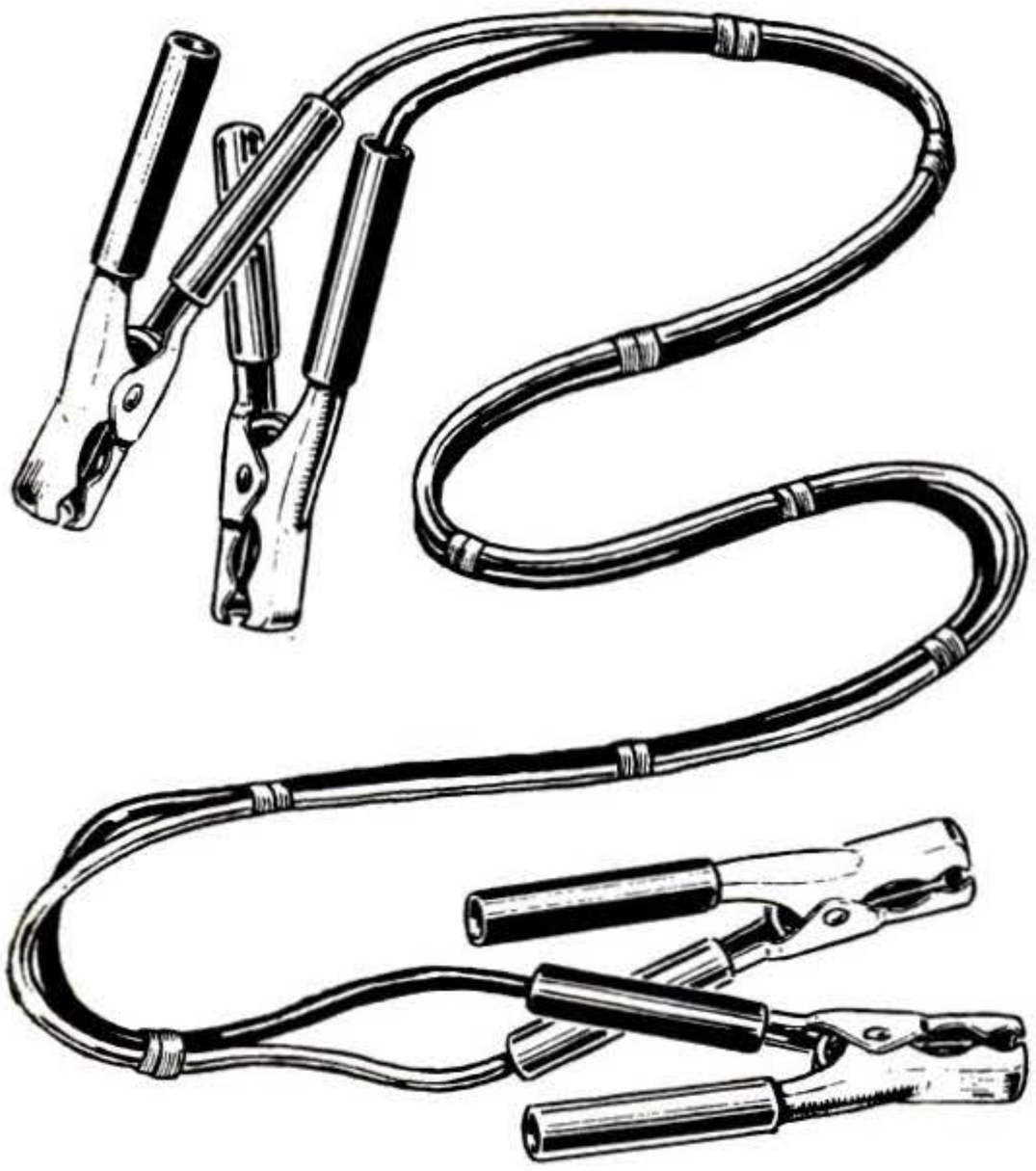
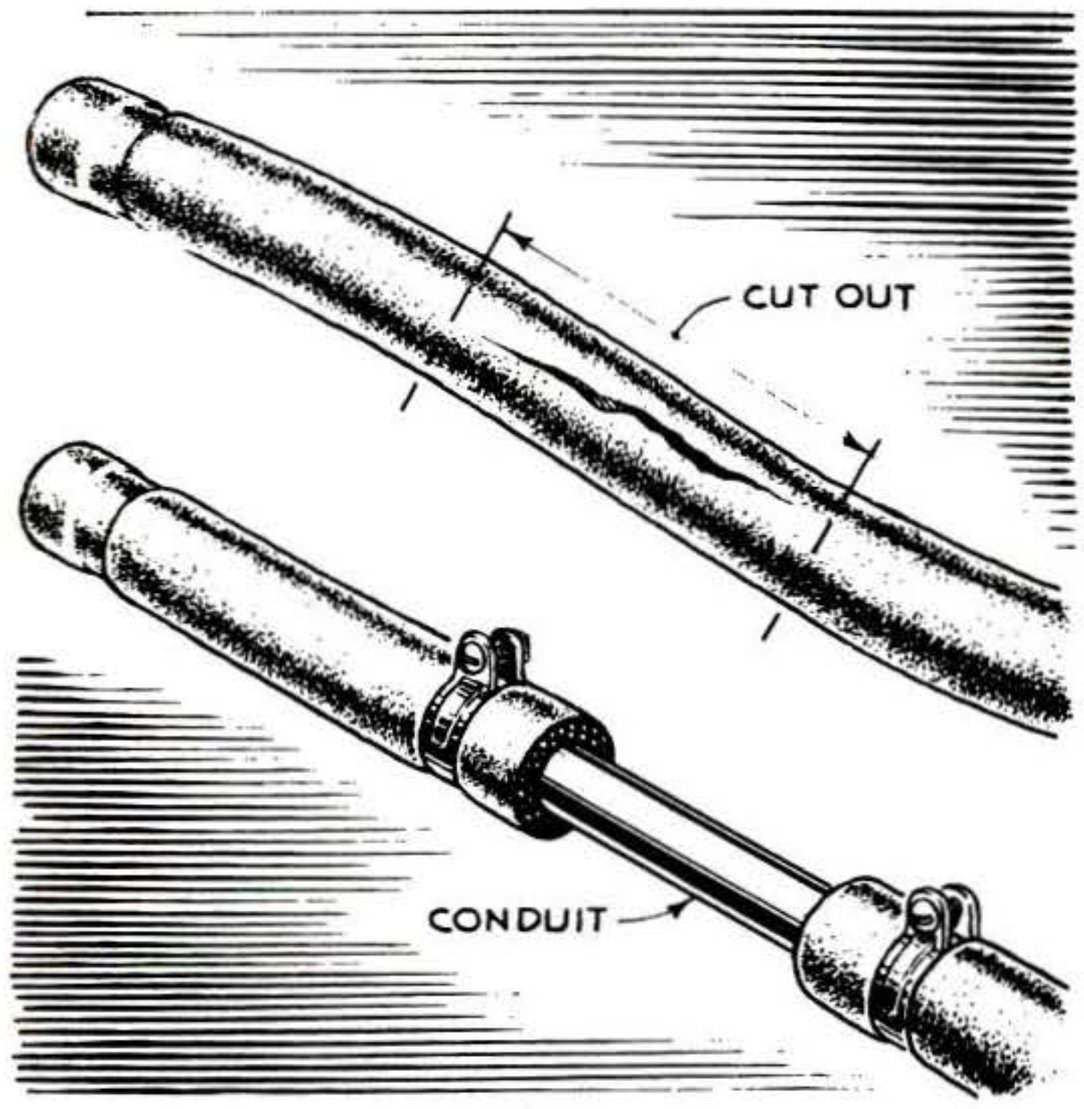
More Hints from the Model Garage



Battery jumper cables won't get tangled if you tape them together at short intervals. Be sure to leave about 18″ free at each end to allow the cables to be hooked up easily. After they're used, they can be coiled up neatly and easily for storage.

A hinged reflective sign hanging from the trunk lid can save your life when you make emergency repairs at night. It's made of a 4′-by-8″ piece of ¼″ plywood with red reflecting-tape letters. A cupboard door catch holds it up against lid till needed.



Burst radiator hose is easily repaired with a piece of thin-wall conduit and two hose clamps. Use ½″ conduit for conventional ⅝″ hose. This splice also can be used to make a permanent repair at any point where the hose rubs and wears fast.

For traction in snow, one reader writes that "chicken grit"—crushed granite—is better than sand. It doesn't absorb moisture as sand does. One handful of the coarsest grit usually is all that's needed. Feed stores sell 50 pounds for about $1.

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Gus Settles a Family Feud

By Martin Bunn

LEAVING the dairy where he had just revived a moribund milk truck, Gus Wilson turned his wrecker into Dwight Road. Even this early, there was a long line of cars waiting for driving-license tests. At sight of the uneasy applicants and bored inspectors, Gus reflected on how long ago he had taken his own first test.

He had driven halfway past the lineup when the head car pulled out. Closing in to three car lengths behind it, Gus saw it was a 10-year-old jalopy, brave in hand-brushed, streaky body paint and whitewall wheel disks. Sitting ramrod straight beside a broad-shouldered inspector was a black-haired teen-ager.

The car moved off jerkily, as though some of the youngster's nervousness communicated itself to steel and rubber. Making an avenue stop, with Gus now close behind, the boy started around a corner just as a station wagon whipped out from the curb across his path. The car stopped, and the wagon raced off. As Gus waited patiently behind the car, its starter churned.

The engine came to life, but the car hadn't budged before it died again. The boy's neck stiffened with tension. Again the engine caught. The car lurched off as its young driver let the clutch grab. At the next corner he turned left—from the wrong lane and without giving a turn signal. Gus shook his head in silent sympathy and drove on.

"*We just got a call* for a rental battery and recharge, Boss," reported Stan as Gus drove into the Model Garage.

"I might as well go right out on it, while you finish that brake job," said Gus.

Stan hoisted in a charged battery and gave Gus the address.

It was a big new split-level just outside town. Gus pulled into the driveway behind an almost-new Ford.

"Thank you for being so prompt," said a voice as he stepped out of the truck.

With mild surprise, Gus saw that the speaker was a round-faced Chinese. He had the bland expression that Westerners associate with Orientals.

"We try to be," returned Gus. "Shall I test your battery first?"

"If you wish, but I am sure it is discharged. I must go into the city at once. If you will recharge it, I will bring back your battery later today."

"Sure thing," agreed Gus. He noted that the battery and terminals were clean and the clamps tight, but his meter showed every cell below par. In minutes he had

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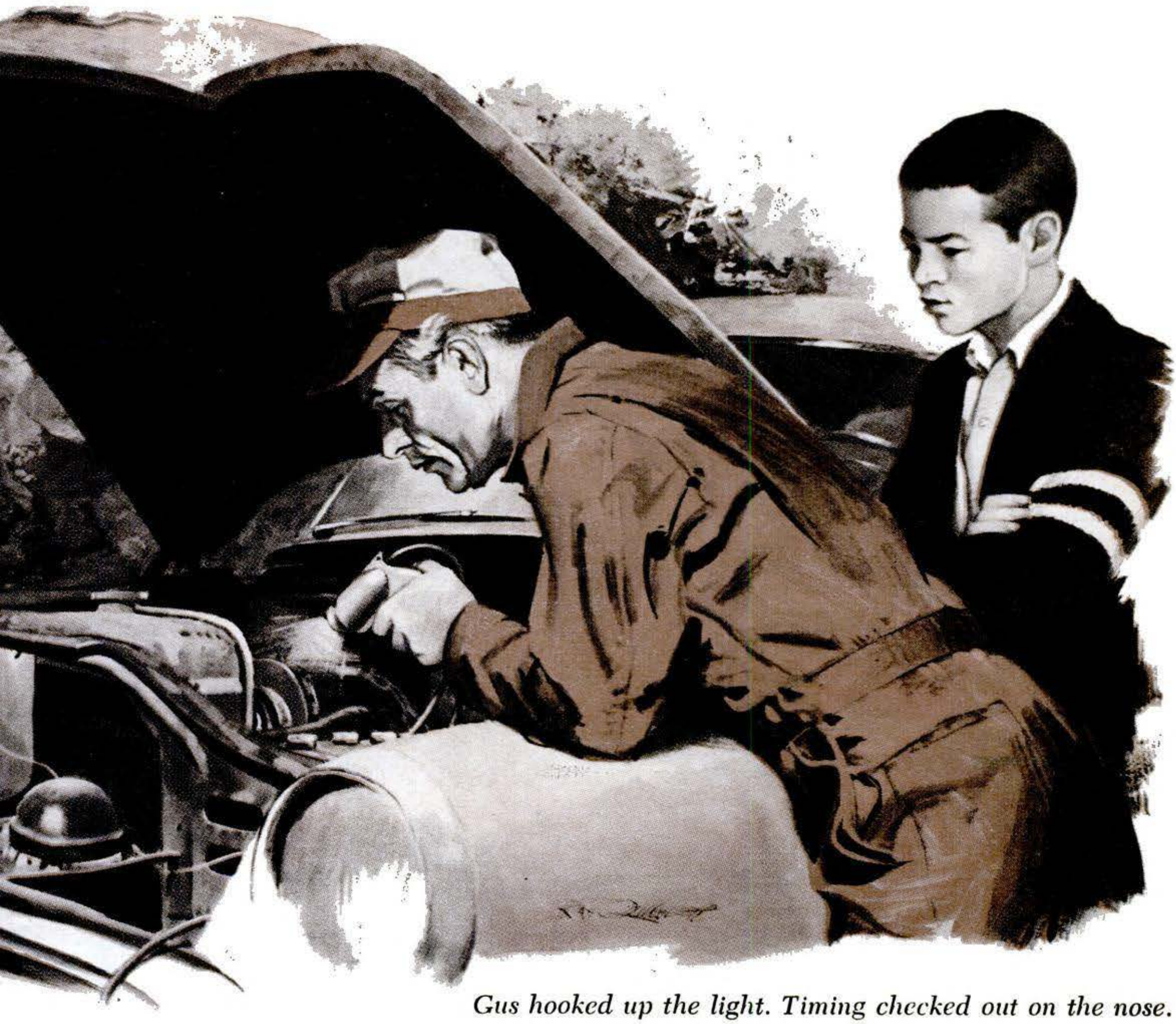

Gus hooked up the light. Timing checked out on the nose.

the rental battery in place. It cranked the engine with enthusiasm.

"That will get you there," he said. "The car's new, isn't it? Normally the battery shouldn't run down. Drive much at night, or use the radio a lot?"

"Because it is new and I am not used to it, I have not yet driven it at night," the man answered. "But once last week the battery was dead. I complained to the agency that sold the car. They made electrical tests. All was okay."

"Could just be a bad battery."

"They say it is good. That time, my son had the radio on all day as he cleaned the garage. Yesterday, when he was alone here, I think he practiced driving for the license test he's taking today. Often he lets the clutch out too fast, so he must start the engine again and again. That is why the battery is now so weak."

"We'll put it on charge. You can have it any time after four," promised Gus.

It was after three when an ancient Dodge chugged into the shop. Gus recognized the hand-painted finish and white wheel rims he had seen that morning. From the venerable jalopy stepped Ernie Byers, a high-school senior Gus had watched grow up.

"Got a stumper for you this time, Mr. Wilson," said Ernie. "But first meet Tommy Chang. His dad's opening a big new Chinese restaurant downtown."

The slim, black-haired youngster who stepped from the car raised a hand and grinned in greeting. "Hi, Mr. Wilson. Ernie says you're tops. If you can settle our beef, I'll sure go along with that."

"Well," said Gus, "I better tell you I was behind you when you stalled this morning, Tommy. Still want me to try?"

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Tommy's round face sobered. "Sure do. Because I didn't stall both times. The engine just quit. That—and maybe something else—got me so rattled I flunked out."

"Better luck next time," said Gus.

"I hope so," said Tommy soberly. "Anyway, somebody's got to cure this jalopy of what ails it before I shell out $85."

"That's my price for the crate," explained Ernie. "The deal was that I'd put in a new coil, condenser, oil filter, and points, let Tommy take his driving test in the car, and he'd buy it."

"But not if it's going to cut out and go dead," put in Tommy.

"I just drove you here," retorted Ernie. "It never missed a beat, did it?"

"Okay, let's see." Gus snapped open the distributor. The points proved to be set right within the tolerance range. The new condenser was tight, all connections secure. He buttoned up the distributor, hooked up the timing light, and started the engine. It ran smoothly. Timing checked out on the nose, and the spark advanced smoothly as the engine was revved.

"All okay, isn't it?" asked Ernie.

"Seems so," agreed Gus. "Only—"

"Yeah, what?" asked both boys.

Gus turned to the Chinese lad. "Only *you* know, Tommy. How far up was the clutch when the engine quit?"

"A bit, the first time, when that wagon ran in front of me," admitted the youth. "But the second time the pedal was still on the floor. I'd just touched the gas."

Gus grunted. It had seemed to him that morning that the engine hadn't stalled, but died. He felt the low-tension ignition wires for internal breaks, scanned them for worn insulation, and found neither. Again he opened the distributor.

"I took it apart and cleaned it before I put in new points," said Ernie.

"Did a good job," murmured Gus, fingering a small, wasp-waisted retainer clip on the vacuum-advance shaft. The clip turned easily in its groove.

"Look at this," said Gus, and three pairs of eyes converged on the clip. "Say the engine's running fine and you gun it. The extra vibration makes this clip turn. Ever see that toy with a propeller on a notched stick? You rub the notches—and the prop turns. Same here. It doesn't matter, until the clip swings like this."

Gus turned it. "Now it's touching the breaker arm, and shorting out the points. No spark. Engine's killed."

"Hey!" breathed Tommy. "You're okay."

"Guess you spread that clip a bit taking it off, Ernie," suggested Gus. "But you can fix it." He handed the boy a pair of sharp-nosed pliers.

Removing the clip, Ernie carefully bent back the ends of the legs, squeezed the encircling loop a trifle smaller, and replaced the clip. It now turned reluctantly in its groove, and the legs safely cleared the breaker arm.

"Okay, Tommy? Deal?" asked Ernie.

"Sold," agreed the Chinese lad, pulling a sheaf of bills from his pocket. "Thanks to Mr. Wilson."

He had just counted them out when a sleek new Ford rolled in.

"Oh man," groaned Tommy. "It's Pop!"

"He doesn't know about our deal?"

"Oh, that's okay—Pop's kind of square, but he's a good guy—it's something else. He thinks I drove his new bus yesterday." The slanted young eyes were somber. "First time he's ever thought I'd lie."

Gus walked over to the Ford as Mr. Chang got out, staring at the two boys, who

"Got those valve tappets set yet?" asked Eddie. "I need the feeler gauge to adjust these new points."

Slim withdrew the gauge from the last tappet. "Just done. Here, take it."

Ten minutes later Eddie snapped the distributor cover on. Both boys listened with satisfaction to the smooth, highly responsive engine.

"Best points I could buy," said Eddie. "Set just right on the high side of the tolerance range. Won't have to look at them till long after we get back from our West Coast trip."

But though the rest of the ignition system was faultless and the points had indeed been properly adjusted, they failed before the car had covered 500 miles.

...How Come?

ANSWER: Eddie hadn't wiped the feeler gauge bone dry before using it. Oil transferred from the valve tappets to the point surfaces was carbonized by the spark, contaminating and burning the points quickly.

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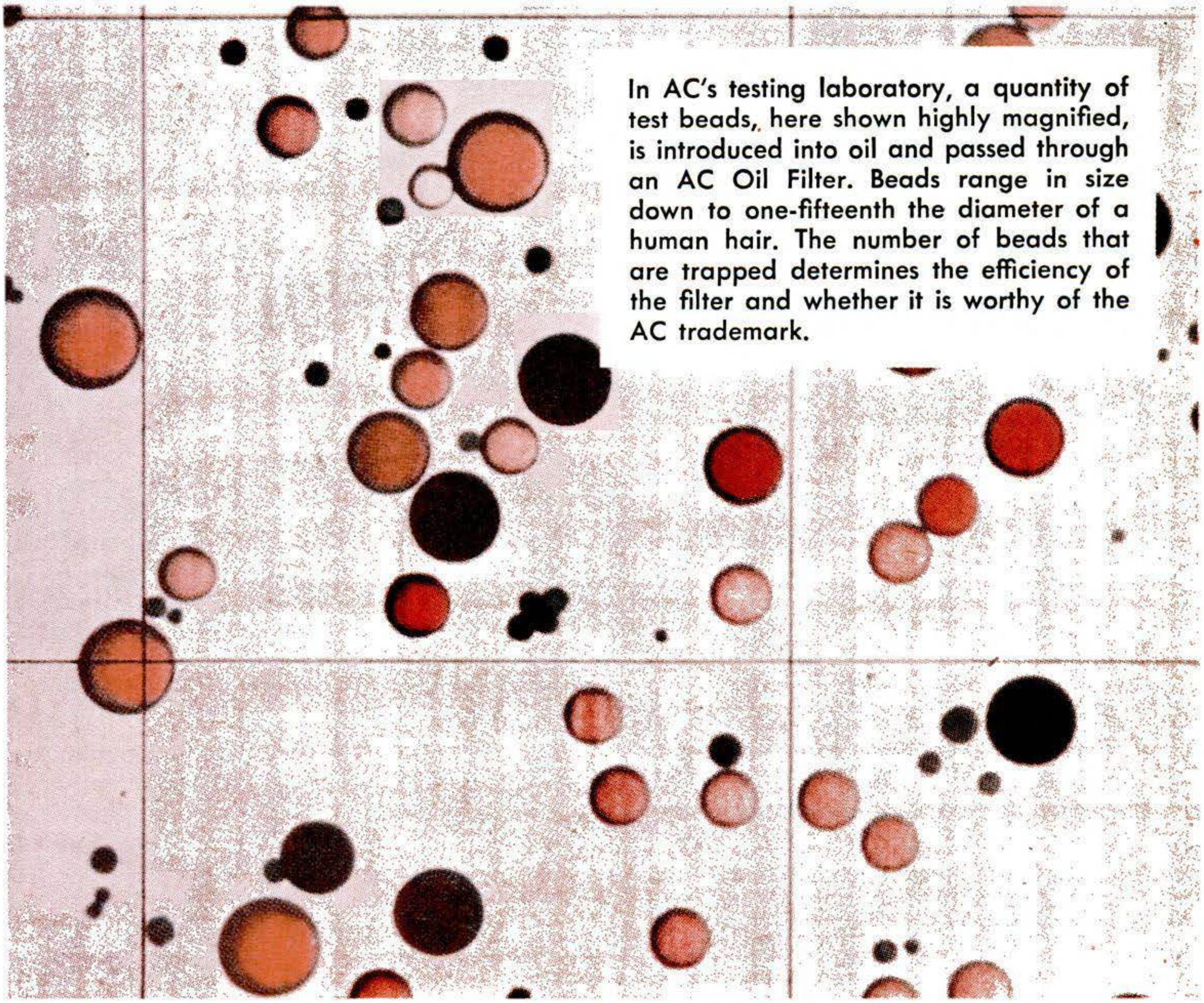
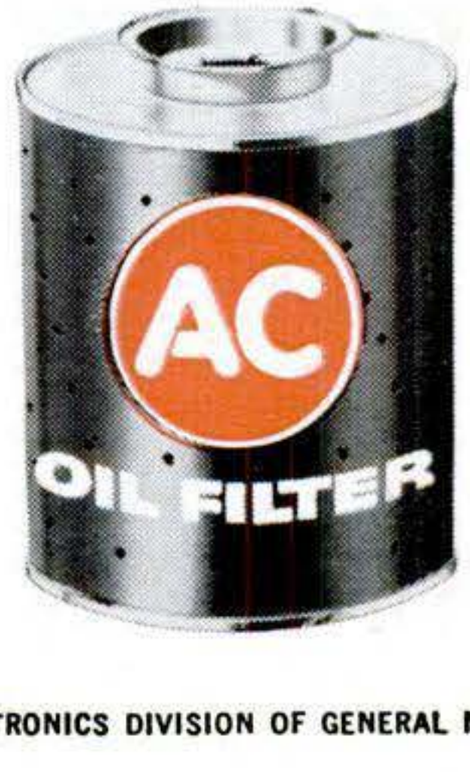
AC Oil Filters trap dirt too small to see



In AC's testing laboratory, a quantity of test beads, here shown highly magnified, is introduced into oil and passed through an AC Oil Filter. Beads range in size down to one-fifteenth the diameter of a human hair. The number of beads that are trapped determines the efficiency of the filter and whether it is worthy of the AC trademark.

Controlled porosity means better filtering action — better protection for your engine

The superior filtering action of AC Oil Filters is due to the controlled porosity of the filter paper. This means that the paper is carefully controlled for density, pore size, strength and uniformity. It has low restriction to oil flow yet filters out particles too small to see. Result is a cleaner, smoother-running engine that lasts longer because of reduced wear on bearings and other vital parts. Get an AC Oil Filter with your next oil change and get the best filtering action that money can buy.



AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

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stayed quietly talking near the other car.

"So you know Tommy, Mr. Wilson? He is my number-one and only son."

"Just met him today, Mr. Chang. How was your car? Battery okay?"

"I am not sure," said Chang slowly. "When my business of some hours was finished, it seemed to me perhaps the starter turned more slowly than when you put in this battery."

For a long instant Gus looked into the man's dark, unreadable eyes. There was something, Gus realized, that Chang wanted very much, and Chang knew that he knew it. Without a word Gus got into the Ford. As he turned the key, the engine cranked briskly—as it should after a long drive.

Getting out, Gus connected a test meter to the voltage regulator. It cut in and out reliably. At a thousand revs, the generator charged at the specified rate. All connections were firm. Gus shut off the engine, checked fuses and under-hood wiring for any trace of a short, past or present. There was none.

Inside the car, Gus briefly tried the horn, dome light, heater, and headlights. All worked normally, but he paused with his fingers on the headlight switch. The knob and escutcheon felt warm.

Unscrewing a lock nut, Gus released a spring catch. He pulled out the switch with its connected wires and something else—a coiled resistance element sticking out of the ceramic barrel of the dash-light dimmer. Gus found Chang beside him.

"Here's the trouble," said Gus. "This resistance wire is supposed to be wound on the insulating ceramic. It came loose and was free to touch the dash. When it did, enough current drained off to kill your battery in a day or two."

"But I have not driven at night. I never touched that switch," said Chang.

"If you had, you would have noticed it was warm. Didn't matter whether it was on or off—that resistance wire is alive all the time. You got a short whenever it touched the dash, but going through a resistance, it was never enough to blow a fuse. I'll clip off the wire and you can have the dealer put in a new switch."

"I am grateful," said Chang quietly. "For your help with the car and because you have showed me I was wrong in an important matter. I must speak to my son tonight."

Chang had paid and driven out, his original battery back in the Ford. The two boys strolled over to Gus.

"Thought we'd better wait and let you get Pop straightened out," said Tommy.

"It wasn't hard," returned Gus.

"Guess it's up to me to pay for our job," put in Ernie. "What's the tab?"

"It's Tommy's car, isn't it?"

"Yeah, but I agreed—"

"Your father paid for what I did on the Ford, Tommy. Your job is on the house."

"And you're invited to a special dinner on opening night, Mr. Wilson, also on the house. But what's this jazz about my job being free because Pop paid for his?"

"Oh that," said Gus, straight-faced, "that's what I call my family plan." ■■

Swedish Army gets turretless tank

A new 35-ton tank is so low it gives an enemy little to shoot at. It has no turret; its steering and suspension let it aim its fixed 105-mm. gun and four machine guns by traversing and elevating the whole tank. A 300-hp. Boeing turbine and a 230-hp. Rolls-Royce engine (for cruising) power it. Volvo, Landsverk, and Bofors built it.

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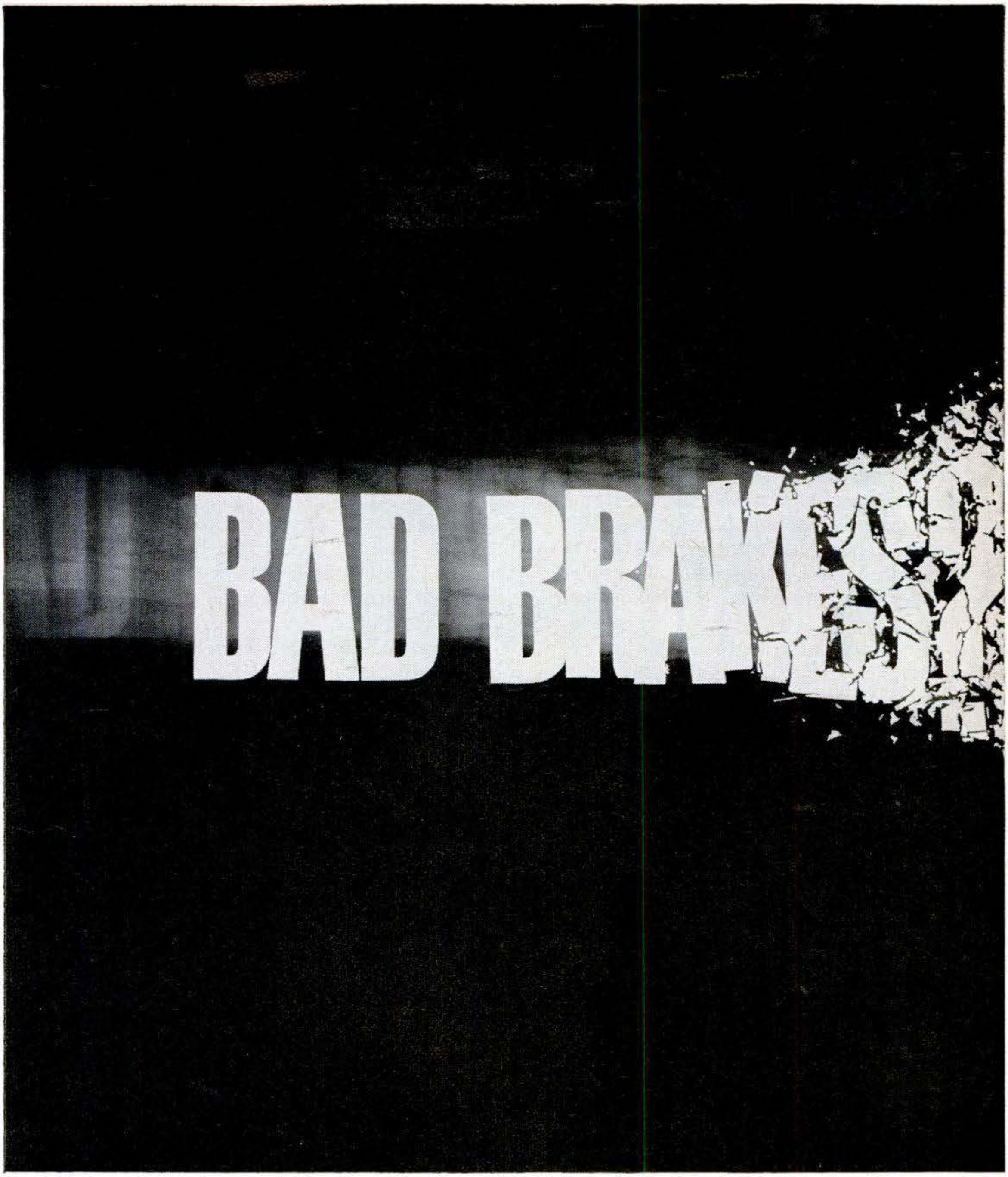

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[Continued from page 144]

Two features could be improved. I found the rocker-type toe-and-heel shift lever awkward to operate and the speedometer dial small and sparsely marked.

Taken altogether, however, as any machinery must be, both road and competition model Sprints are a skillful blending of Italian and American engineering: excitingly exotic yet reassuringly familiar. The road model has a $695 price tag (f.o.b. Houston); the competition job is only $25 higher.

How much difference is there between the two Sprints, aside from their price tags? There's quite a bit, both in performance and in visible hardware. The competition model went five miles an hour faster in each gear than the road model, for example. At 271 pounds, the competition machine is 10 pounds heavier; but this is more than compensated for by three extra horsepower and one less tooth on the transmission sprocket.

The competition model has a much smaller gas tank (2.6 gallons); a high-level air intake, engine exhaust, and crankcase breather; and slightly larger tires (3.00 by 18 and 3.50 by 18). These differences make the Sprint H a true off-the-road bike.

A joint venture. How these handsome half-breeds were born and what makes them go is as unusual as their appearance. Two years ago the Harley-Davidson Motor Co. entered into a corporate marriage with Aeronautica Macchi, S.p.A. The American firm provided money and a long-established dealer network that covers the United States. The Italian firm provided a road-ready motorcycle and production facilities. For the Milwaukee firm it meant filling the last gap in a broad line-up of models; for the Milan company it meant distribution and capital.

The Sprint's European origin is most apparent in the design of its frame and engine. A tubular backbone, rather than a full loop, connects hydraulic front forks to pivoted rear forks whose movements are dampened by shock absorbers. A single-unit crankcase and gearbox hangs from the backbone, with a cylinder barrel and head jutting forward from it. The backbone-type frame has the virtues of simplicity and light weight, while the horizontal engine layout provides a low center of gravity, excellent cooling, and repair accessibility.

Inside the Sprint's four-cycle engine is a single piston that displaces 15 cu. in. (246 cc.). Two overhead valves are opened and closed by pushrods. Compression ratio on the road-model Sprint is 8.5:1; it develops 18 hp. at 6,700 r.p.m. The competition-model Sprint H has a 9.2:1 compression ratio and puts out 21 hp. at 7,250 r.p.m.

A "plain-tube" carburetor angles sharply downward into the uppermost side of the cylinder head. Sticking out of the carburetor body are a choke lever and a primer button. The lever adjusts air intake, the button primes the carb with gas if empty.

Crankcase and gearbox form a single, compact unit. Compactness is due mainly to the one-cylinder design: one connecting rod rides on a short crankpin between a pair of close-set flywheels. But the space-saving primary drive deserves some of the credit—it has helical gears instead of chain and sprockets.

A multiple-disk wet clutch. This robust mechanism of eight plates, obviously reflects Milwaukee's experience with hard-riding Americans. Connected to it is a four-speed, constant-mesh gearbox; final drive is by conventional chain and sprockets. All of this internal machinery is so ingeniously arranged that the power package is deceptively small.

The Harley-Davidson touch is also clearly visible in the electrical system. Ignition is by battery and high-voltage coil, the same as on most cars. A camshaft-operated circuit breaker sparks the plugs.

Current is supplied by a potent six-volt DC generator that charges an eight-ampere-hour battery. The generator's output begins to climb at a mere 1,300 r.p.m. At 30 m.p.h. in fourth gear the output is 15 amperes; this levels off at 45 to 21 amps.

In case the battery should die of neglect or abuse, the machine can be started by flipping a switch on the underside of the headlight and pushing briefly in high gear. Generator juice then flows directly to the circuit breaker long enough to fire the engine. Snapping the switch back to normal position reconnects generator to battery.

Sprint is the first Harley-Davidson made outside the United States in the company's 60-year history. It may be a distant cousin, but the family resemblance is clearly—and reassuringly—evident. ■ ■

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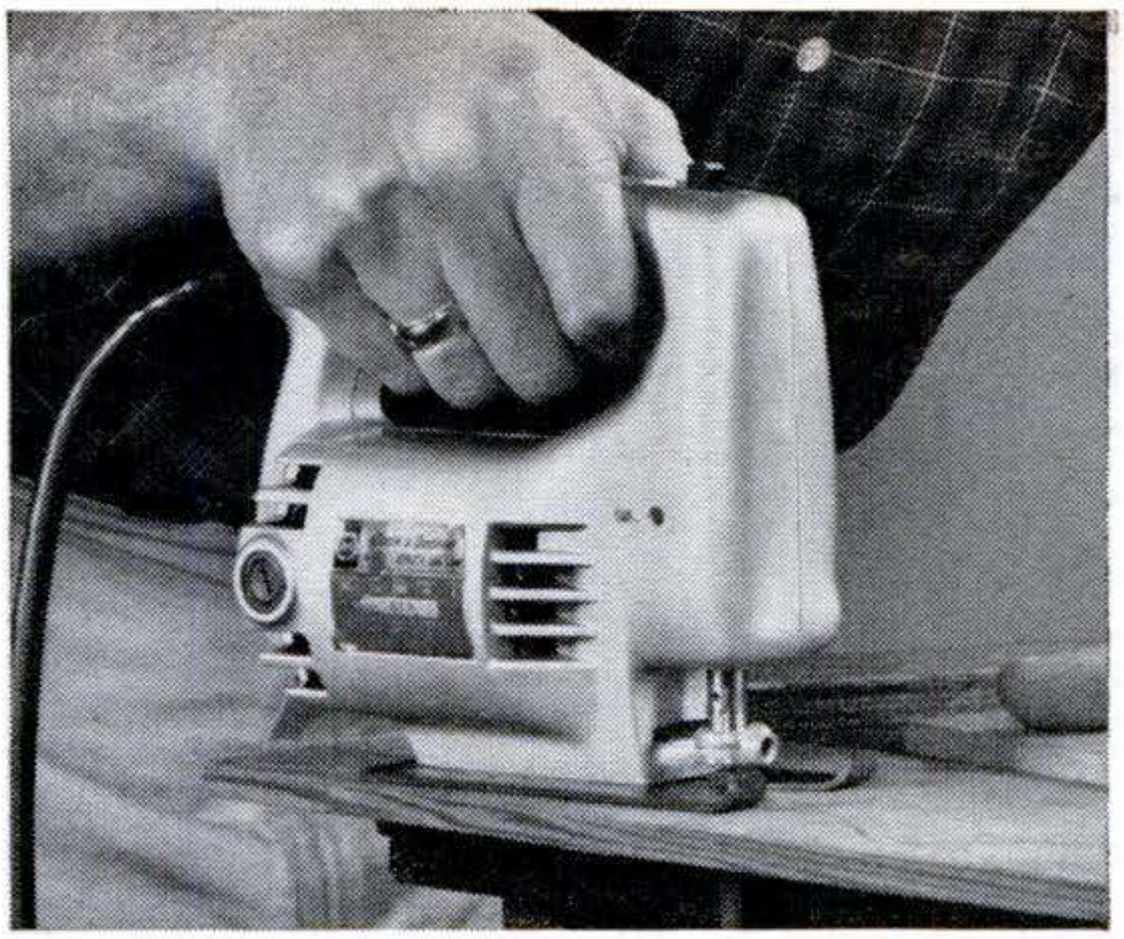

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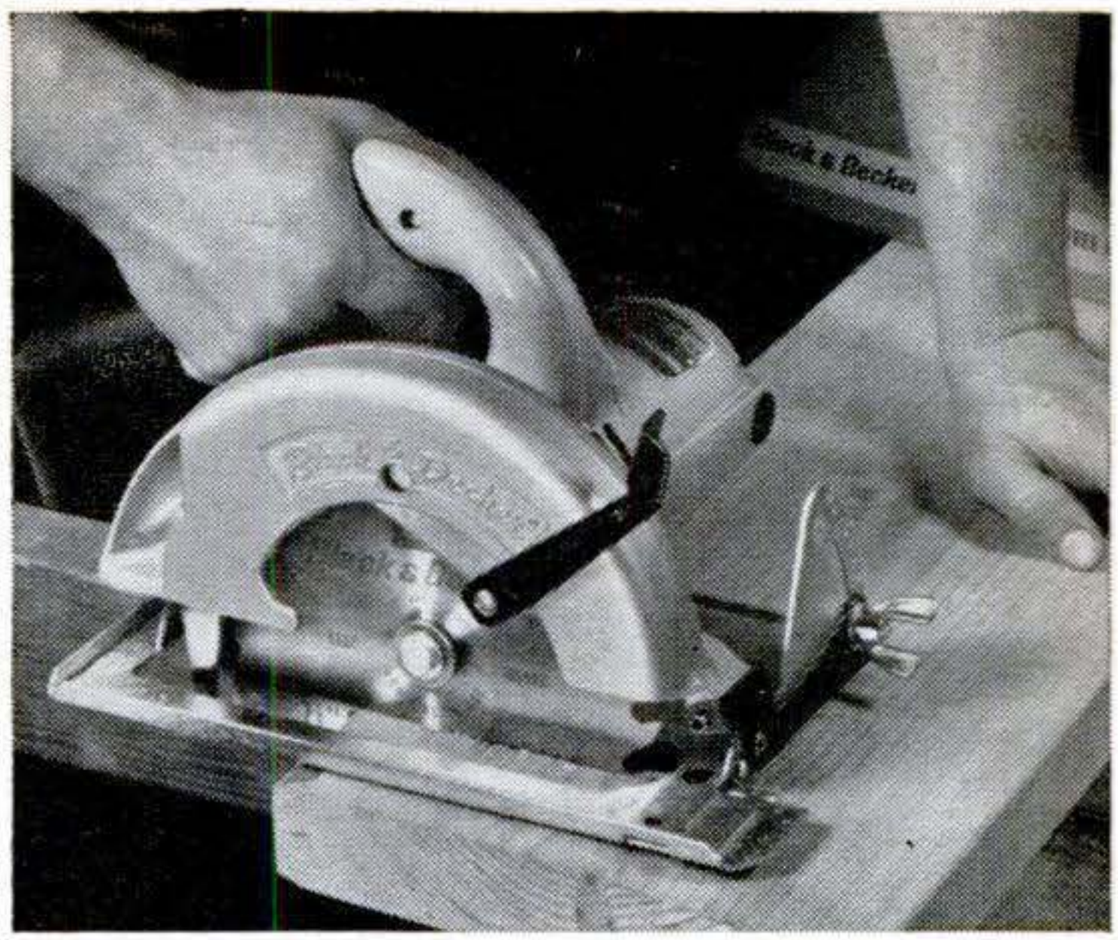

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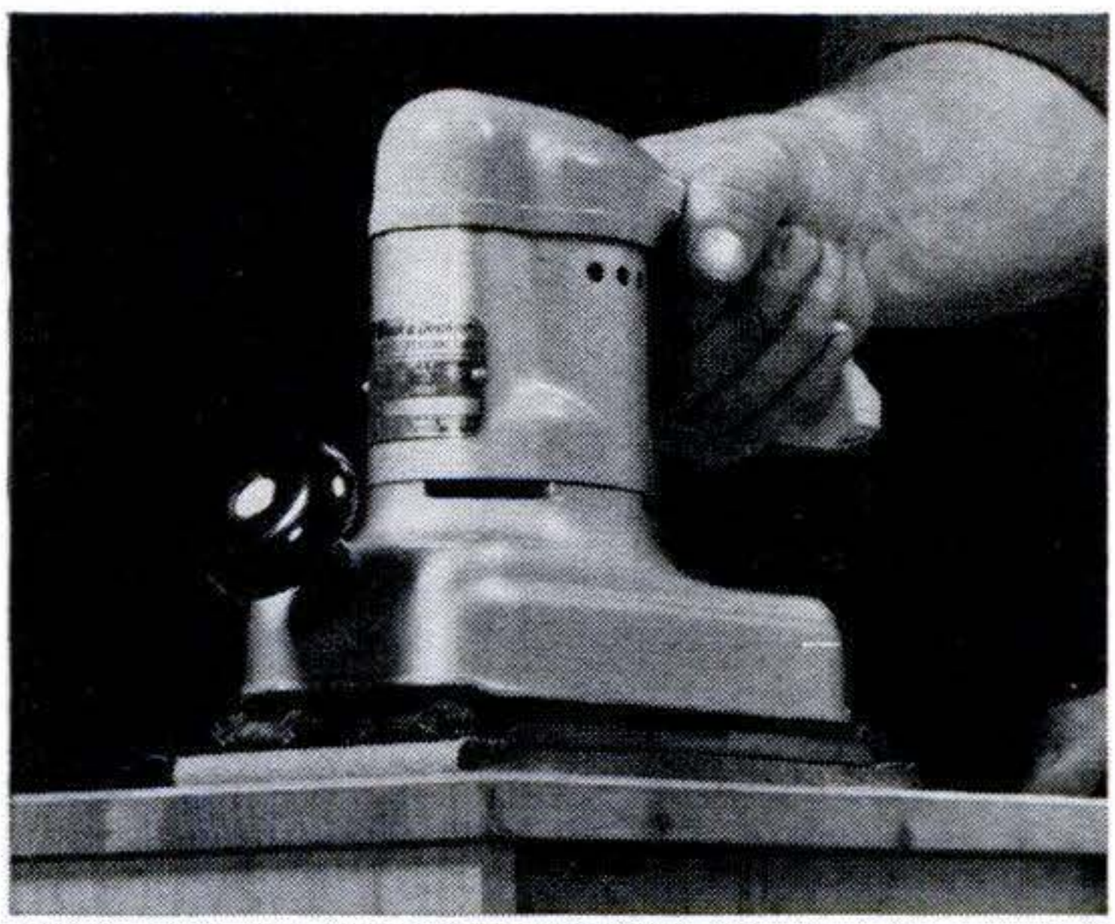

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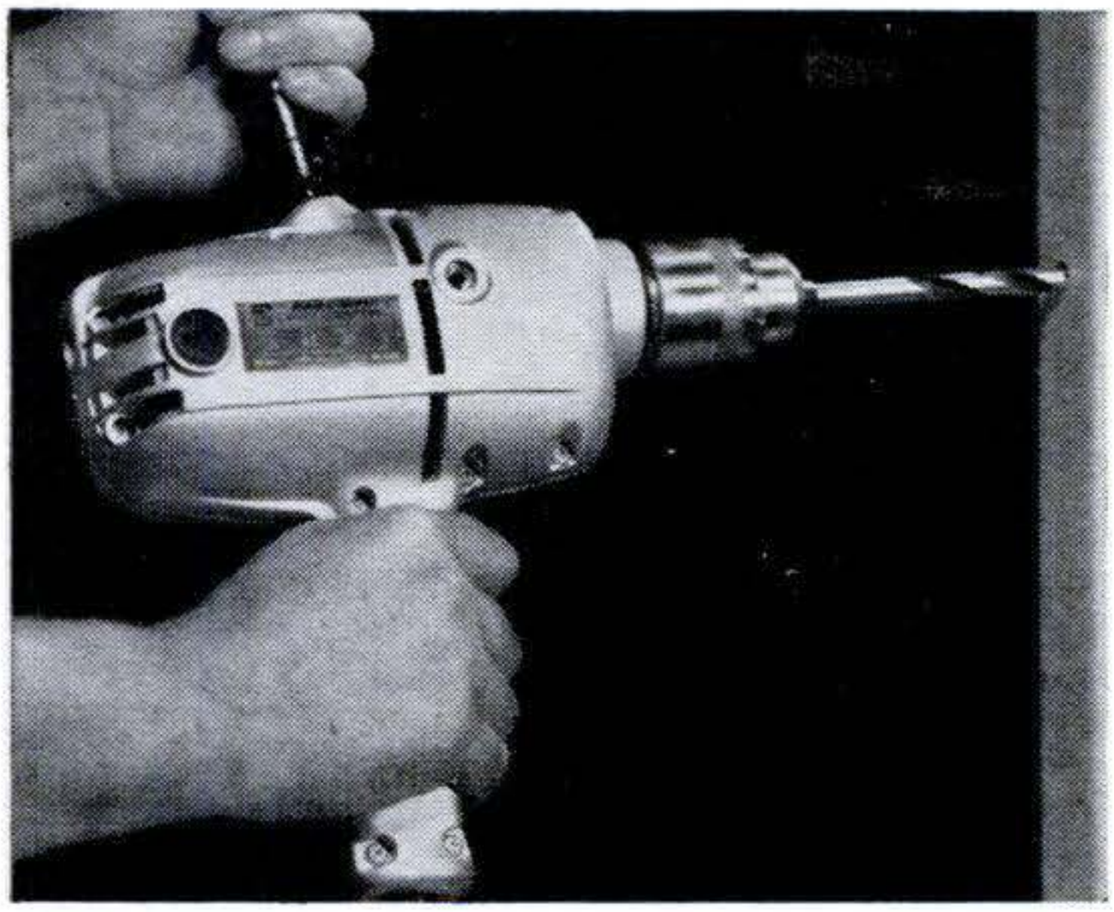

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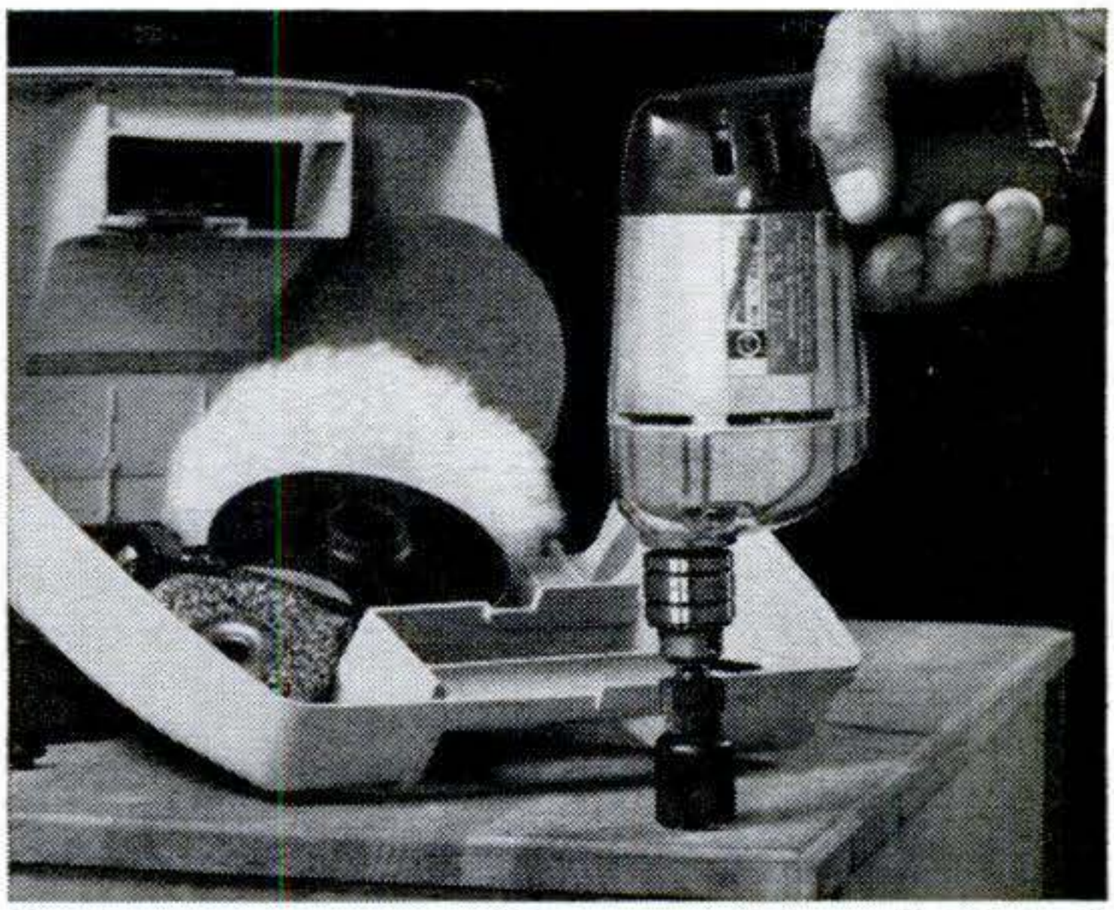

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[Continued from page 124]

sider unpatented ones. One firm that takes inventions at any stage is Tigrett Industries, of Jackson, Tenn. It's headed by John Tigrett, one of the country's top invention experts.

The question that Tigrett hears most frequently from inventors is: "How do I know they won't steal my invention?"

"The idea that companies steal inventions is a myth," Tigrett told me. "It's cheaper for them to negotiate a royalty agreement than to risk litigation. I've handled hundreds of inventions, patented and unpatented, and I've never heard of anyone stealing an invention."

Should you use a broker? If you want to eliminate the nuisance of peddling your own invention, you can. Many patent attorneys will help you follow through on sales. There are reputable invention brokers and patent agents, such as K. O. Kessler, who operate on a percentage basis. With their considerable know-how in negotiating agreements, as well as their knowledge of markets, they are well worth patronizing. You should be warned, however, that there are some "brokers" who don't do much for you. Make sure that the man who undertakes to sell your invention really has the experience and facilities he says he has. Check with the Better Business Bureau before signing up.

Another possibility is to set up your own company and keep all the profits for yourself. To do that, of course, you have to *want* to run a business, and have some business qualifications.

Take the case of Al Creighton, a young Boston economist who cooked up a concoction of resin and metal powder into "plastic steel." He figured that his putty-like metal, the formula of which he didn't want to disclose, would be hard to sell to an existing company. He knew just what his product would do; he'd mixed up considerable batches of it in his kitchen. And he thought that he could get salesmen carrying other lines to take on his product and show it during their calls on hardware stores and other outlets.

Creighton rightly figured that he had a perfect setup for his own business—a conclusion since confirmed by the fact that now, 10 years later, he does a comfortable $3,000,000-a-year business.

His story, like those of almost all successful inventor-operated companies, has the ingredients necessary for success:

- You've got a demonstrably marketable product.
- The production problem is not heavy.
- A selling method is available.
- You can raise the capital.

The Squangle story. For an instructive blueprint, an inventor pondering making-his-own could hardly do better than to study the way Ove Hanson of Seattle worked it out. Hanson invented the Squangle, a combined variable-angle square, level, protractor, and handsaw guide. He had a real handy item for home craftsmen, and knew he could find a company to buy it. He reasoned, however, that his device might be lost in the line of a big company. Sell it to a small one? Yes—but Hanson figured he had his problems so well under control that he might as well start his own business.

First, he knew that his invention was salable: He had made up a number of Squangles by hand, and they had been snapped up by craftsmen.

Production? No problem there. He didn't need a factory. After he had his dies made, Hanson found a number of local machine shops that had presses standing idle at odd hours. He arranged to use them at lower-than-usual rates. Assembling and packaging he did in his garage.

As for selling, Hanson didn't need a sales force. He had no difficulty finding manufacturers' representatives who were glad to take on an extra line.

The all-important matter of capital was handled locally. Hanson put in some of his own money and persuaded friends to put in the additional money needed for getting started. Later, with a going enterprise, he had no trouble raising $10,000 more for new dies and larger inventories. The success of the Squangle was now well known enough in his community to make it easy to sell stock to 25 local people.

Squangle may not have made Ove Hanson rich, but it has brought him a return far beyond anything he could have expected by selling it in any other way.

Does your invention meet the basic specifications for success? Is it useful, workable, producible, and marketable? If it is, no matter how you decide to sell it, you can figure that the odds are in your favor. ■ ■

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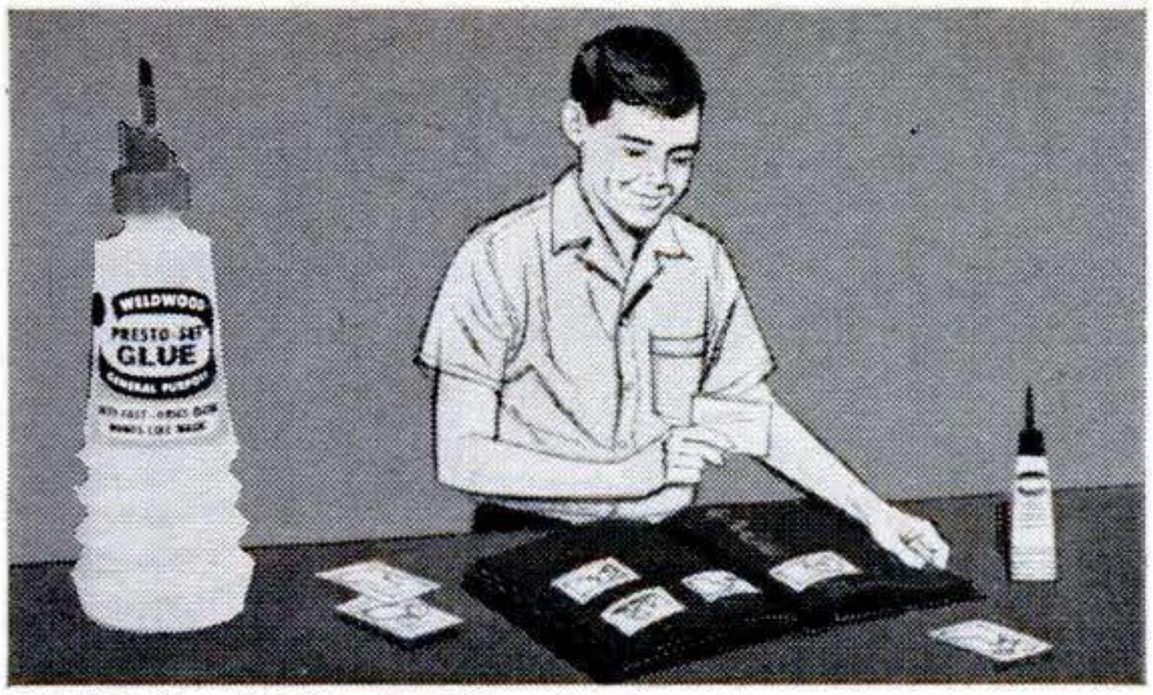

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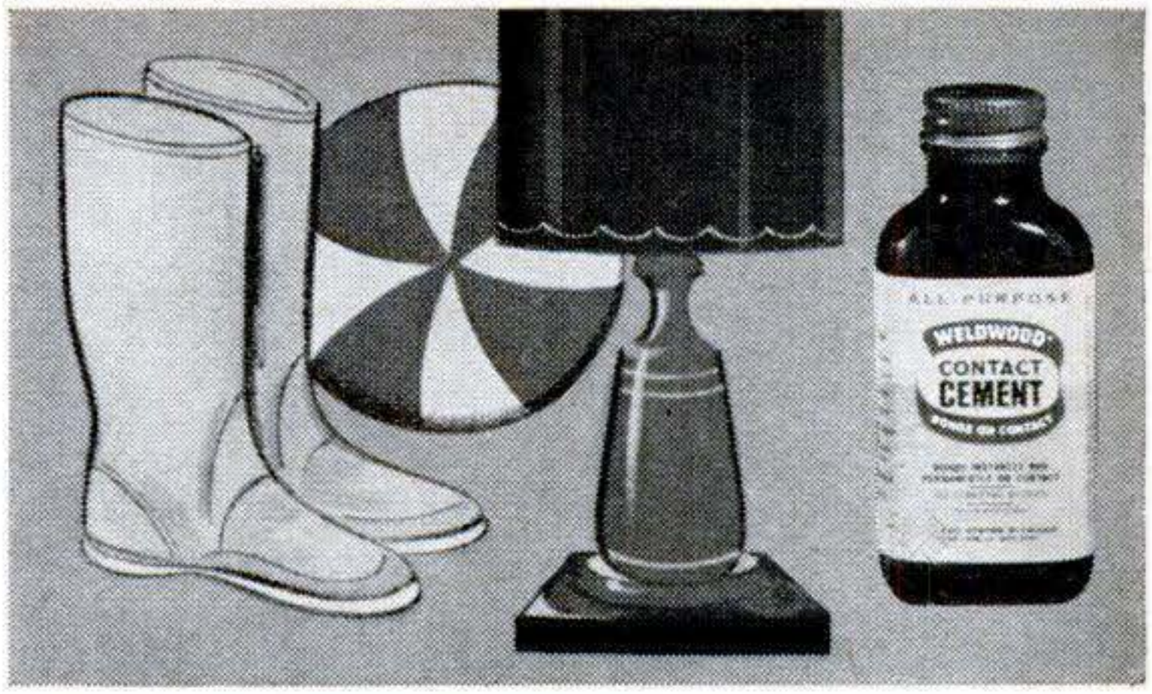

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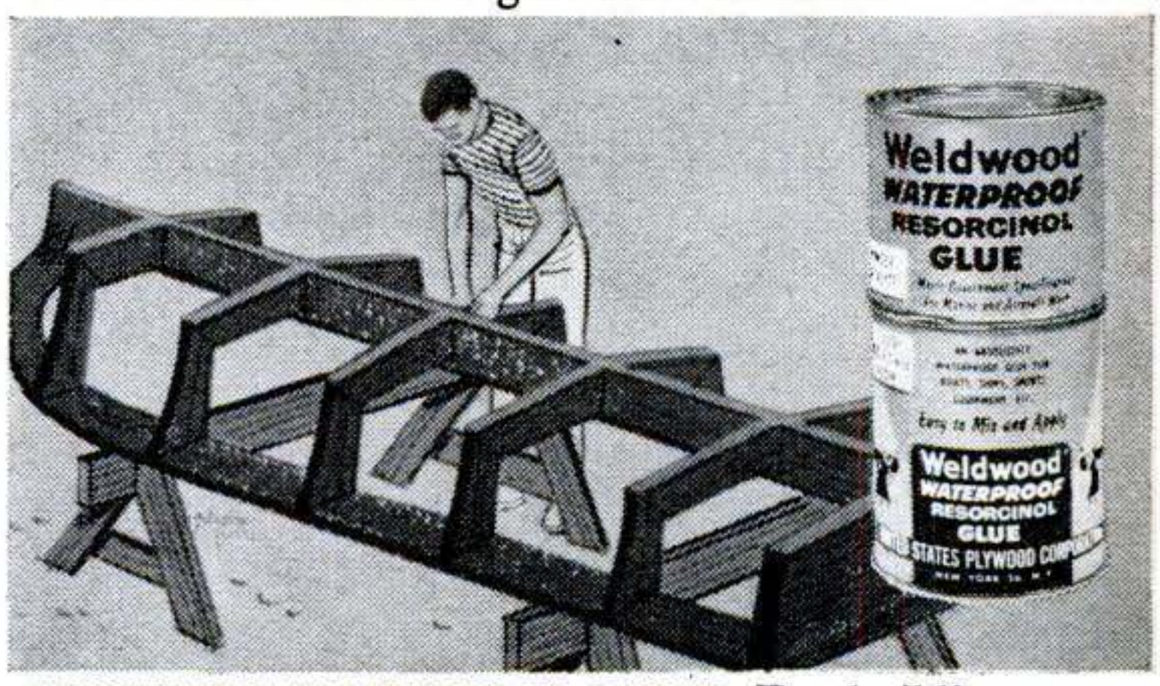

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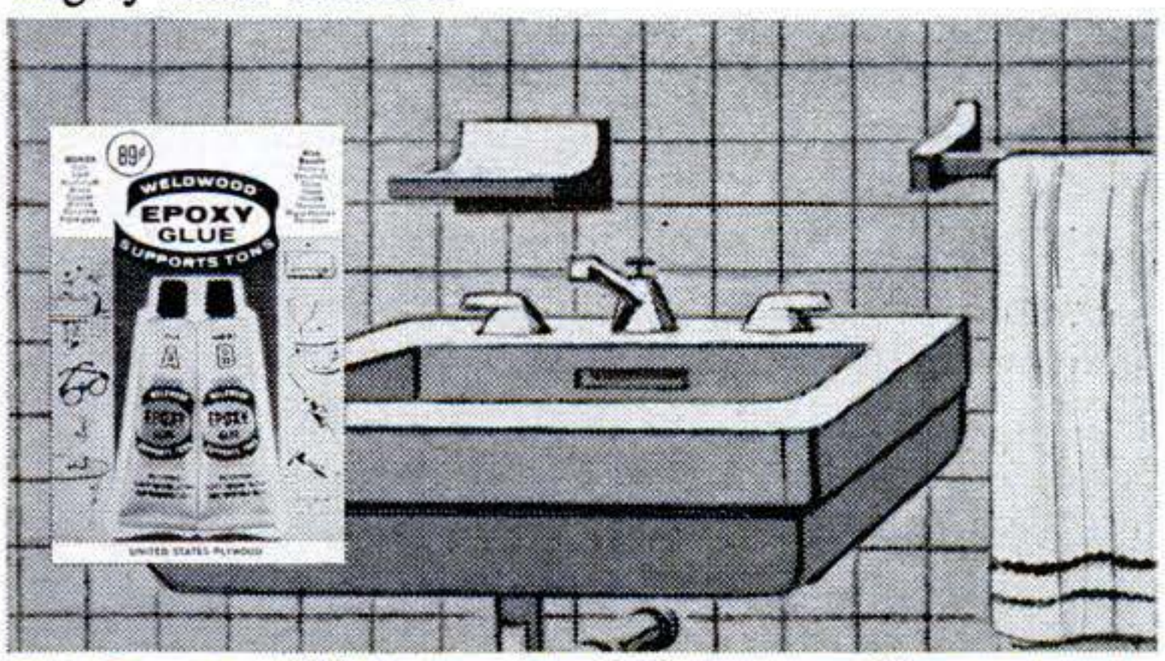

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[Continued from page 121]

connaissance, I asked for an example. The shot selected, with an interpretation made especially for POPULAR SCIENCE, is shown on page 118. It demonstrates how a PI uses observation and deduction to tell almost as much about a factory from a sky view as he could from a stroll through the plant.

To aid him in his detective work, the interpretation expert uses a battery of special instruments and techniques. With a stereoscopic viewer, which gives a three-dimensional view of the terrain, a stylus, and a pair of dividers, the PI begins his work.

First comes measurement. He has several choices here. He can use scales built into the viewer and measure the height of buildings or smokestacks or the elevation of the ground. He may see a plane or truck he can identify. If so, he uses its dimension as a basic yardstick. He may know the height of telephone poles in the region under study. With this information he can measure the length of a pole's shadow, then find the height of other structures by measuring their shadows. Simply by knowing the altitude of the plane and the focal length of the camera lens used, he can calculate the scale of objects on the ground. Using one or more of these approaches, he can measure accurately to within a few inches.

Then there's the blink microscope to spot important targets. Suppose the PI is looking for new factory construction in a large city. By carefully examining photographs made on consecutive days or weeks, he could finally find minute changes. But the blink microscope makes it much easier.

To use it, the PI gets two identical photographs of an area taken on different days. He aligns the prints under the twin lenses of the microscope until they are exactly superimposed in the eyepiece. Then he turns on the blinker, which alternately blocks out one photograph, then the other. Identical features in the two photos continue to look like a single image. But anything new—a new building, for example—will appear to flicker, since it is on only one of the prints.

The human factor. The most powerful—and perhaps the most basic—tool the PI brings to the job is his reasoning ability. Seemingly unimportant clues—and a little deduction—can yield startling results. One British PI during World War II noticed that the Germans always installed engine-testing dynamometers in special buildings that were easy to spot from the air. Walt Rostow, a reconnaissance expert (now a State Department official), put together a map showing the location of every dynamometer building in Germany. He reasoned that each dynamometer could check a given number of engines a day. So he counted the dynamometer buildings at each engine plant to figure the plant's output and pinpoint which ones to bomb first.

Expert knowledge plays a vital role, too, as proved by Constance Babington-Smith, one of Britain's foremost PIs during the war. In 1943, she reported to headquarters that a fighter base at Marienburg had been converted to an aircraft factory, even though there was no sign of a change in activity seen from the photograph. Her clue: The planes were parked differently. From past experience she knew that regular Luftwaffe pilots lined up their planes neatly on the ground; test pilots just parked anywhere.

Balloon photos. Aerial reconnaissance had its start during the Civil War. In 1862, General McKennan of the Union Army sent up a photographer in a tethered balloon to get shots of Confederate lines. Two prints of the aerial photos were made, and each was divided into 64 numbered squares.

On the day of the battle, the general sent up his balloonist with one of the photographs; he kept the other on the ground. When Confederate troops moved, the balloonist telegraphed to the ground their new position. The Confederates never did find out why Union reinforcements always showed up to face the Rebs.

In spite of its early start, it wasn't until World War II that aerial reconnaissance became an important weapon. One of the first triumphs of the new technique came in the summer of 1940. PIs spotted a series of newly trodden paths along the French coast. Soon networks of telephone wires appeared. Reconnaissance flights were stepped up, and alerted PIs spotted the first 12-inch guns moved into the new emplacements. Converging telephone lines pinpointed headquarters as clearly as signposts would have done. And truck tracks over the dirt roads and open countryside marked ammunition dumps for Allied bombers.

Perhaps the most famous coup of Allied photo reconnaissance during the war was the discovery of the famous V-1s and V-2s. In the fall of 1943, PIs spotted strange-

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looking long, narrow buildings at some 150 locations in France. Next to each was an inclined ramp, pointed toward London.

Clue to a V-1. PIs put this evidence together with other clues gathered from air photos of Peenemünde on the Baltic Coast, and decided that the Germans were working on a flying bomb. When the first rocket—a V-1—showed up on a French launching ramp, they were sure. From then on, regular photos were taken of all launching sites. As soon as one neared completion, Allied bombers blew it out of the ground. Because of aerial-reconnaissance warning, the V-1 program was a flop.

Much tougher were the V-2s—the world's first true missiles. Launch pads for these deadly birds could be a few feet of asphalt, a wide place in the road, even a raft of planks laid on level ground. Since the launching sites could be moved easily, aerial surveillance was virtually useless and the V-2s blasted London mercilessly.

The Germans, meanwhile, were making one of their biggest mistakes of the war. Although their superb camera plants were turning out excellent equipment, military-intelligence officers largely ignored the fine points of interpretation. After the war, warehouses full of valuable German photographs were found. Captured reports showed that they had been given only the most cursory examination.

Although our photo interpretation was amazingly accurate in World War II, PIs were sometimes fooled. In 1943, the Japanese on New Britain painted phony aircraft on the runways. From 20,000 feet, they looked like the real thing. But the Japanese made one small error. The planes weren't moved around enough. When two consecutive Allied pictures showed groups of aircraft in identical positions, PIs knew something was fishy.

Since World War II, our aerial reconnaissance techniques have advanced sharply. Today's films and cameras take pictures that capture 25 times as much detail as those of two decades ago. But even today's most advanced units may be outpaced in a few years by our spy-in-the-sky satellites. Early models of these high-altitude snoopers have been orbited to try to fill the gap left when the U-2 was shot down. Just how successful they are—or may be in the future—is, of course, one of the best-kept secrets of our military planners. ■ ■

[Continued from page 181]

We powered the Futura with a new 85-hp. Mercury, fresh out of the box. This made a hot combo. Along with one of Ray Simek's new easy-handling Ship-Mate trailers, it was an outfit to delight a boatman's heart.

We were on the river in time to watch the race boats take off for New York. As they disappeared downstream, we set out on our own tests. With Glastron President Bob Hammond and POPULAR SCIENCE Editor Bob Crossley aboard, I tooled the Futura out into the middle of the Hudson and opened her up to see what she had.

She had plenty. It took only seconds for the speedometer needle to sail past the 30-m.p.h. mark, and with the three of us aboard we reached a top speed of 36 m.p.h. With more time to balance the load and tune the motor, we probably could have neared 40.

We tried turns first. Going full tilt, we could spin her hard over and still be in no danger of going swimming. She digs in her heels (her longitudinal strakes, that is) and comes smartly around. If the turn is in your direction, you have a real close view of the water, but there's no feeling of instability.

Next we tried some rough water. We had plenty of opportunity to see how a deep-V 15-footer will plow through deep wakes kicked up by herself and by several other accompanying boats engaging in fast maneuvers. We put the Futura through the confused chop at full bore and she sliced it like a piece of cheese. No slap, no bounce, no pound.

We then nosed in to the Albany Yacht Club. This gave us a chance to test the Futura's controls and docking habits. Now, I've had my share of exciting dock approaches and can report from experience that this boat will take you in with honor when your best girl is watching.

After sampling the coffee and rolls at the Yacht Club, we wanted to see how a woman might like driving the Futura. Since boating is one of the few sports the whole family can participate in at the same time, it is important that the lady of the house not only like the looks of the boat but also feel at home handling her. So Mary Elizabeth Crossley, came aboard and took the helm. It didn't take long to see that Mary was enchanted with the

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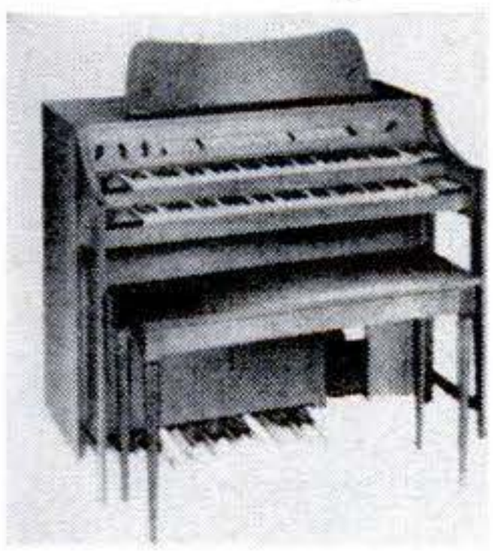

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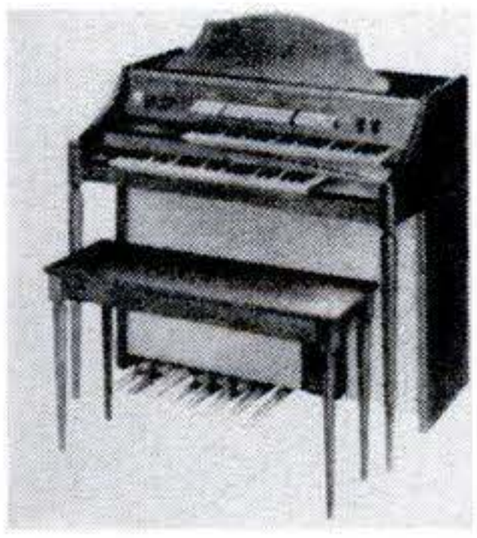

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boat's handling ease. The farther we went, the farther forward went the throttle and the more she experimented with turns and maneuvers.

The driver's seat is back-to-back with another. Paired seats beside it convert to a reclining chair. Long stowage racks on each side hold skis, spare parts, cameras, and lunches. A handy tilting windshield opens partially for ventilation, or can be flipped clear back out of the way. The inside of the boat presents a finished appearance right down to the vinyl carpeting and built-in lighting system.

I found only one thing to criticize. The bow deck is extremely slippery. There was an embarrassing moment when I was very nearly deposited stern first in the oily waters of the Hudson. This problem could be easily solved, of course, by taping a few strips of nonskid material to the deck.

While we were spinning around the upper reaches of the Hudson, the race fleet was heading full tilt for 79th Street in New York. Most of the way downstream the water was relatively calm, but at Haverstraw Bay the race was really decided. Here the river widens and develops a nasty chop. Most of the race fleet took a roundabout course through calmer water near shore. But our 17-foot big sister took the rough water right down the middle to win. Powered by twin 100-horse Mercurys, she made the 134-mile run in 2 hours, 28 minutes. Her average speed of nearly 55 m.p.h. actually beat the running time of fast Albany-to-New York trains.

Another 17-foot Glastron left behind all other outboards last fall at the Salton Sea 500-mile Marathon. Again, it was the Sportsman V-171, powered by twin 100-hp. Mercurys. It covered the 500 miles in 9 hours, 57 minutes in water so rough that out of 73 starters, only 11 boats finished.

Sturdy as she goes. While the chances are you don't buy a boat just for racing, it is always comforting to know that you're driving a hull that proved out when the going was rough. Part of the reason for this ruggedness is in the building methods used in the Glastron plant. An automatic recirculating gel-coat system delivers any one of six colors to a spray booth with a catalyst injection gun. Immediately after the gel-coat operation the boats go through ovens to precure the gel-coat, helping to maintain uniformity.

All the resins are dispensed with high-volume spray guns, utilizing a two-component recirculating pump system. Both resin and gel-coat are preheated during the winter to approximately 95 degrees to improve handling.

All this careful chemistry and automatic equipment produce a superior and uniform hull. This is extremely important in building fiberglass hulls, since one of the few quality guarantees a customer has in buying a fiberglass boat is the choice of a manufacturer who is known to use care and proper materials.

The Futura hull is composed of five layers: first a layer of gel-coat, next a layer of 4½-ounce fiberglass cloth followed by two layers of fiberglass mat, finally a layer of 24-ounce woven roving on the interior of the hull. Longitudinal strength is supplied by three kiln-dried fir stringers bonded with three layers of fiberglass. The plywood floor is bonded in with three layers of mat, nailed on 6″ centers, and then covered with fiberglass. Polystyrene flotation is installed beneath the floorboard. All fittings such as cleats and chocks are reinforced with ⅜″ plywood.

The Futura already has a new and younger twin sister. This boat is so new we did not have a chance to test her. It's an inboard-outboard model known as the V-160 Futura, powered by an 80-hp. Volvo outdrive. Its dimensions match those of the V-150 Futura except for an extra foot of overhang at the transom. ■■

Sidecar can take to water

This little British-built boat fits in a wheeled frame on the side of a motorcycle. As a sidecar, traveling on land, it seats one passenger. Lifted out and launched, the craft seats two, and is propelled by a small inboard engine. Owned by Robert Collins of Delafield, Wis., it's thought to be the only one of its kind in the U.S.

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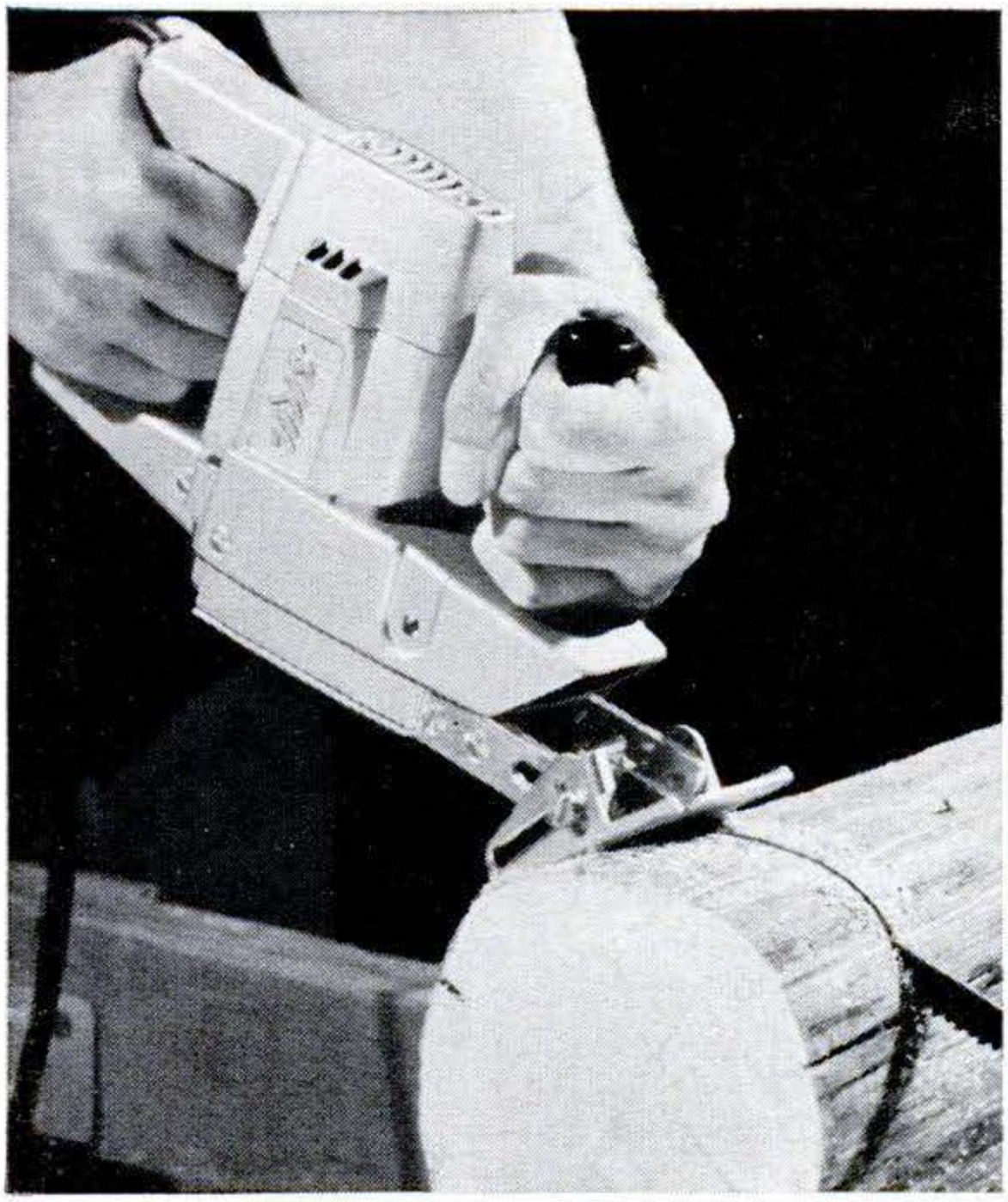

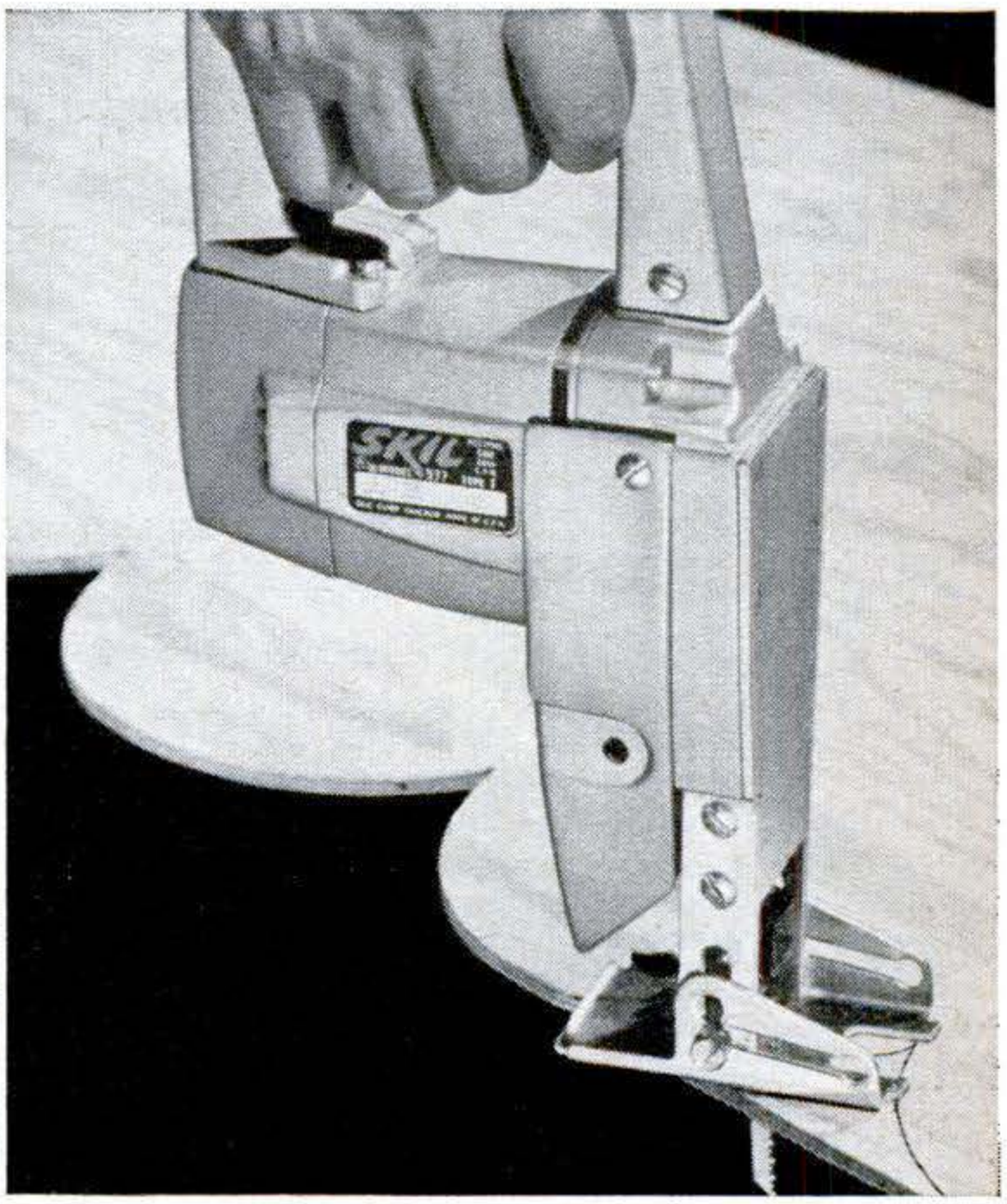

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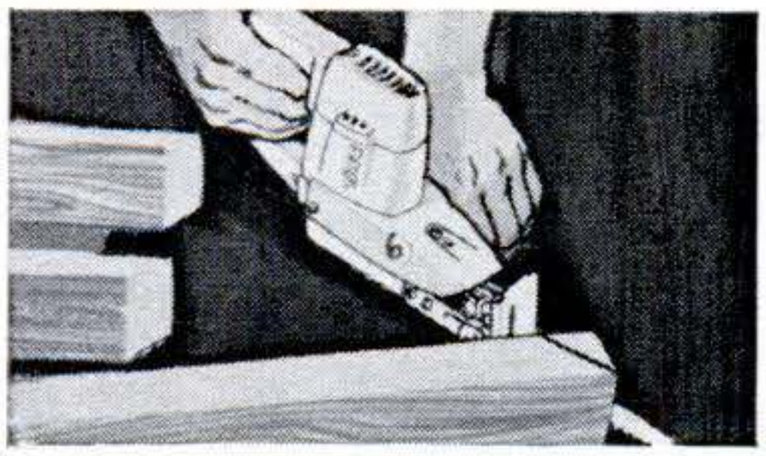
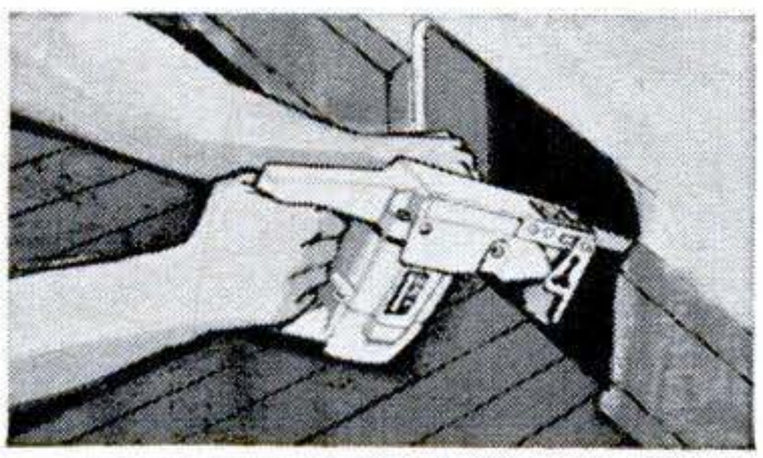
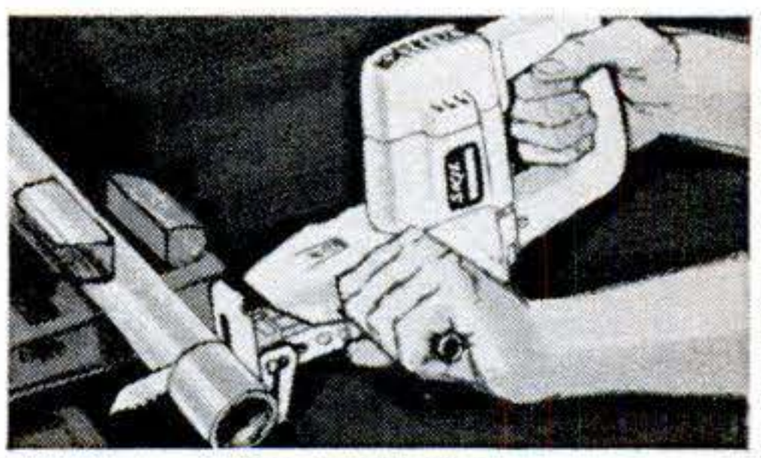


Bevels, Miters



Cuts in Walls, Floors



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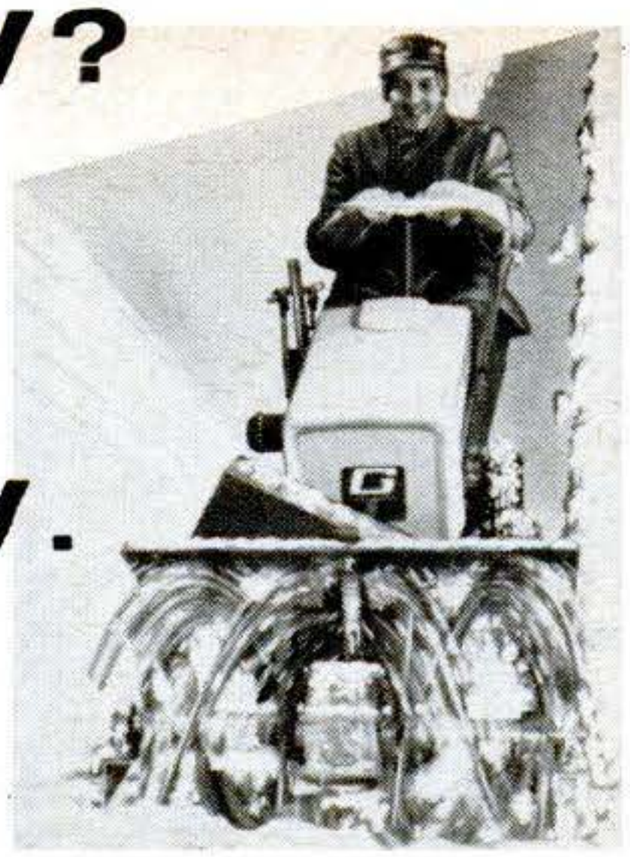

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[Continued from page 80]

arouse the envy of the proletariat—into a series of two, a sport coupe and convertible. The same SS treatment occurs in the Chevelle.

Though Chevrolet now, for the first time, by fiat of the parent corporation, is adhering grimly to the industry's six-year-old resolution not to compete on the race tracks (Ford, Mercury, Dodge, and Plymouth have renounced it), nobody in the division is happy about it. Perhaps it is significant that for '64 the bigger engines, in the 327-409-inch sizes, are being pushed as options. Biggest of these engines, turning out 425 horsepower with two four-barrel carbs, is available with a performance axle that runs in ratio as high as 4.56:1.

Corvair That busy little six-cylinder pancake engine is—surprise!—up again not only in horsepower but in size as well. Entering its fifth year, it displaces 19 more cubic inches for a total of 164.

The horsepowers no longer are 80, 84, 102, and 150, but 95, 110, and 150. Compression ratios are advanced from 8:1 in the 80-hp. version to 8.25, and from 9 in the 110-hp. to 9.25. The ratio in the 150-hp. Spyder remains at 8.

The turbocharged Spyder has invested its increased cubage in a lower r.p.m. for its horsepower, and more torque. It reaches its peak horsepower at 4,000 r.p.m. instead of its former 4,400, and the torque is up from 210 to 232 foot-pounds at 3,200 r.p.m.

All Corvair engines now are built with Spyder parts. Con rods and main bearings are aluminum. Con rods are heavier. Crankshafts are made of alloy steel instead of carbon steel.

But Corvair's biggest news is in its ride. Without sacrificing any of its "boulevard" quality, the suspension has been transformed by borrowing from the Corvette. It transfers some of the engine-heavy rear-end side loads to the front wheels. It also reduces the wind-wander.

Chevy II This opposite number of Ford's Falcon gets a 195-horsepower V-8 for '64 to supplement its four- and six-cylinder engines.

Social note: The Chevy II is down now from three series to two, and its extras for

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conspicuous consumption have shrunk. If you want bucket seats from now on, you'll have to buy up to Chevelle or down to the Corvair.

Corvette The Corvette gets 15 more horsepower for a top sum of 375. The biggest new design feature is a new interior ventilator with an electric blower built into the left rear sidewall. The hood has twin recessed areas instead of simulated grilles. The central divider has been erased from the Sport Coupe's rear window. ■■

Olds Offers Performance, Variety

[Continued from page 87]

Another casualty is the old 215-cubic-inch aluminum V-8. Its replacement—available in the F-85 and in a new full-size model, the Jetstar 88—is a 330-cubic-inch cast-iron V-8, a size exclusive with Olds. It's tagged the Jetfire Rocket. Also available is a V-6 like Buick's.

The new 90-degree V-8 block has a unique inverted-A design; a cast-in horizontal bulkhead between cylinder banks lends extra rigidity. A new foundry process allows thin, uniform-thickness cylinder walls, thus reducing weight.

Another new feature is the combined intake manifold and engine top cover. Advantages: added rigidity, less noise.

The standard 330 engine on the F-85 has an 8.75:1 compression ratio and double-barrel carburetor, burns regular-grade gas, develops 210 hp. A premium-gas H.C. version, standard on the Jetstar 88, squeezes out 225 horses with 10.25:1 compression. A high-performance Jetfire Rocket powers Cutlass models, and is offered optionally on all other F-85s as well as on Jetstar 88s. A four-barrel carburetor and 10.25:1 compression ratio add up to 260 hp.

Olds has a new automatic transmission, basically the new Buick Special unit with a two-speed gearbox.

The big Oldsmobiles are only a fraction of an inch longer. Styling changes are minor, innards the same. Added to the 88 series is the less-expensive Jetstar 88 mentioned earlier. Also new is the Jetstar I, a so-called sports car, really a fancy Starfire.

Added details: cornering lamps on Starfires, 98s, Super 88s, and Jetstar I; a concave backlight on 98s. ■■

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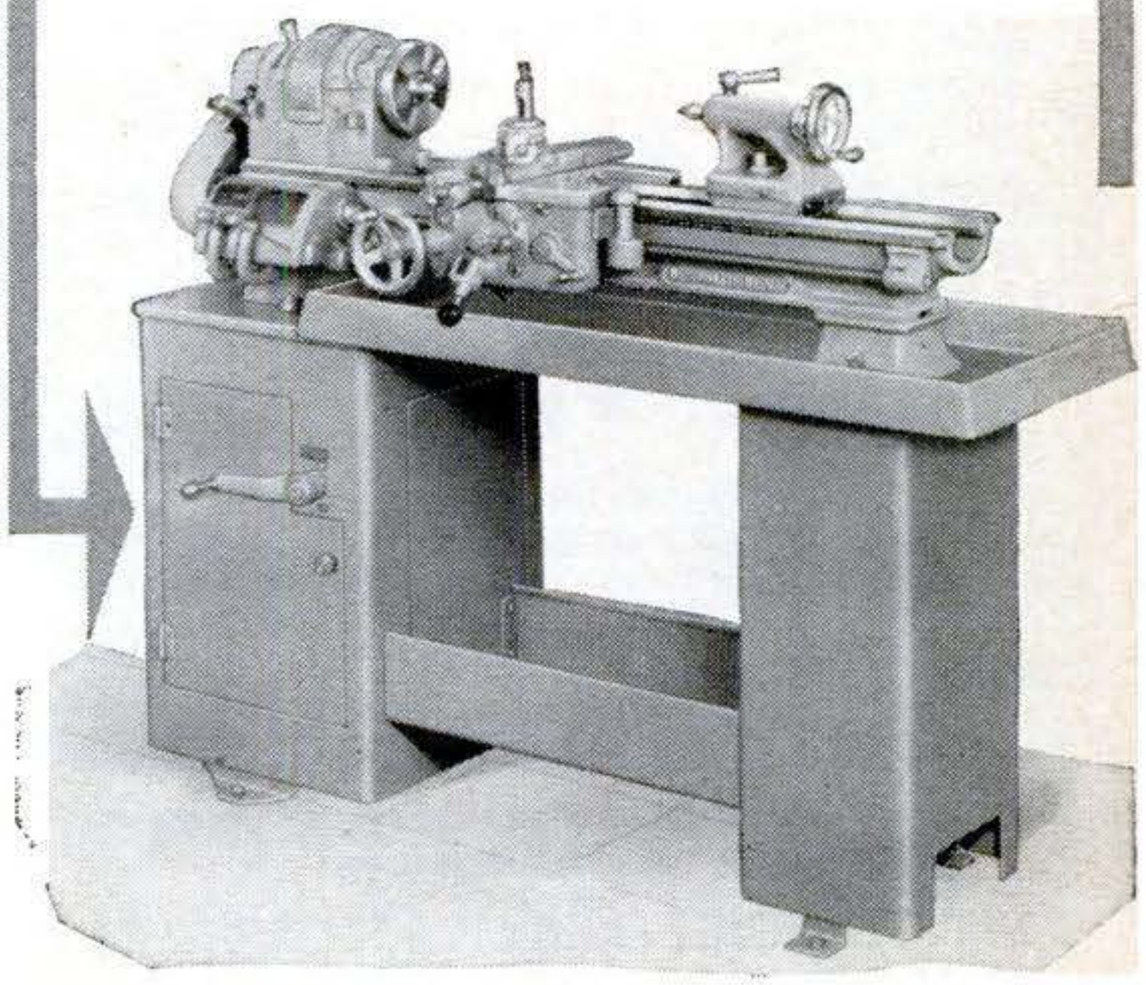

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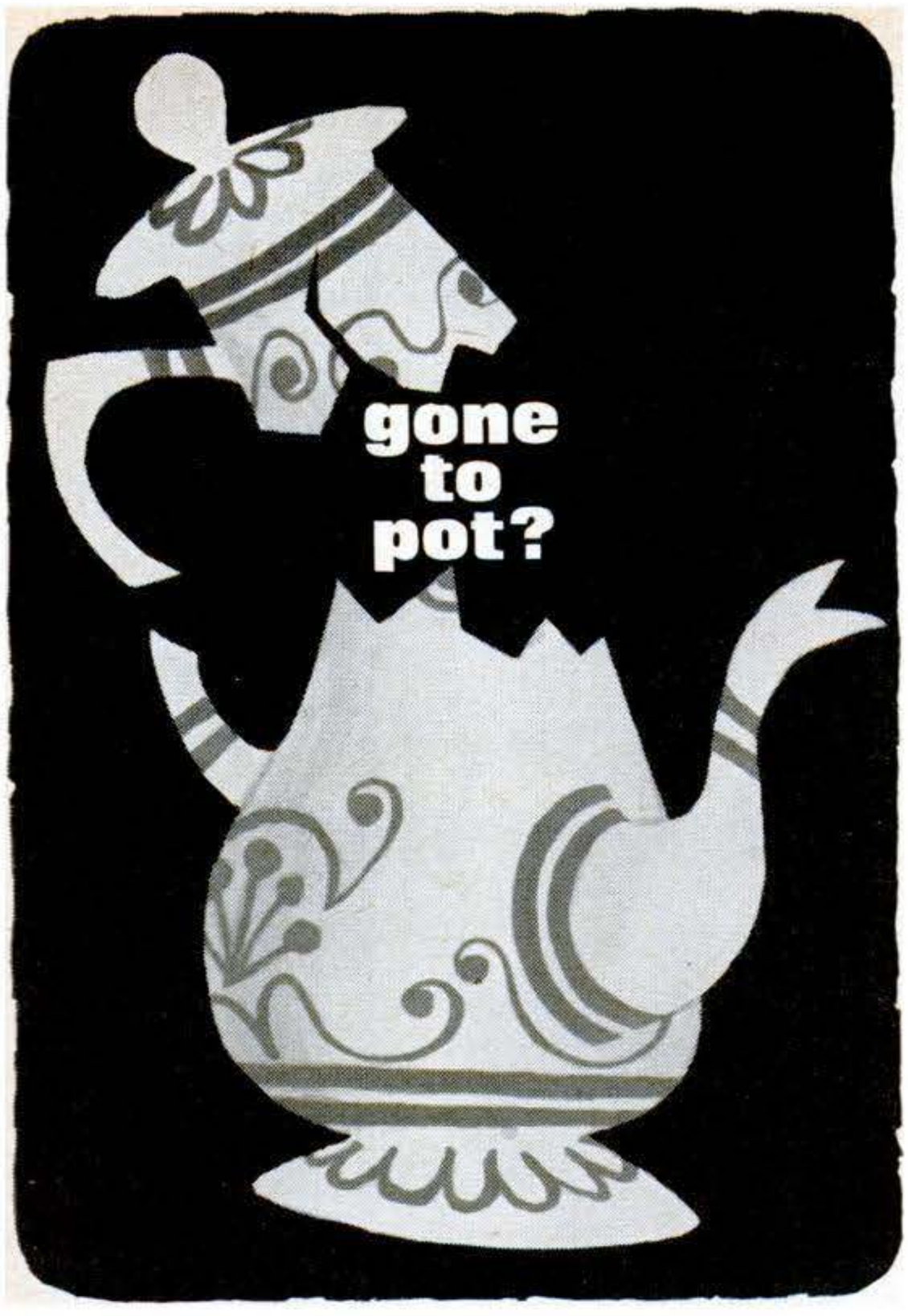

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First Home TV Tape Recorder

[Continued from page 96]

the intricate servo system needed for synchronizing electrical and mechanical elements is very expensive. And the tape itself costs about $70 for 15 minutes' playing time.

Telcan has gone back to the simple sound-recorder principle with a stationary head. They use standard quarter-inch tape, running it at a speedy 120 inches per second. The secret is in the design of the head and associated circuitry. They're keeping it a secret, too—until full patent coverage is sewn up. But it works.

Out at the factory, 30-year-old Norman Rutherford, one of the technical brains behind the project, gave me a demonstration. He switched the TV set to a live program and a pop singer filled the screen. Another switch started the recorder mounted on top of the cabinet. The tape whizzed past as on fast wind, the reels a mere blur. Yet they made little noise.

Playback fuzzy. After a minute he stopped and rewound the tape, clicked over to playback, and the singer re-enacted his grimaces in full voice. The picture was only fair, like a transmission viewed in a fringe area. It had a slightly fuzzy-focus look due to off-beat synchronization caused by a phase shift in the sweep amplifier. Straight vertical lines were smeared into saw-blade edges.

"You're looking at low-cost picture recording on the threshold of its development," said Rutherford with no apologies. "We feel we're headed in the right direction, but improvement will take time." He explained: "The present state of the art is simple in the extreme. It's at the level of 8mm home movies in 1920 when 35mm was the end-all. We're working on a system that will give first-class results in five years."

The Telcan deck resembles a four-track stereo recorder. There are separate heads for video and sound, and the tape can be turned over to double playing time. A single motor belt-drives the capstan and reel spindles.

Connecting the adapter to the TV set is normally a serviceman's job, but an easy one. The unit is wired by coaxial cable between the detector output (for recording) and the grid of the video output tube (for playback). Coax length can be

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six feet. Sound connections are simply to the speaker and the audio input.

At its current level of development the recorder can handle a two-megacycle band width, which is sufficient for the 405-line scanning system in Britain, but would degrade the picture more if used with America's 525 lines or Europe's 625. Basic problem here is the quality of the magnetic tape available, which accounts for the loss of picture definition even at 405 lines.

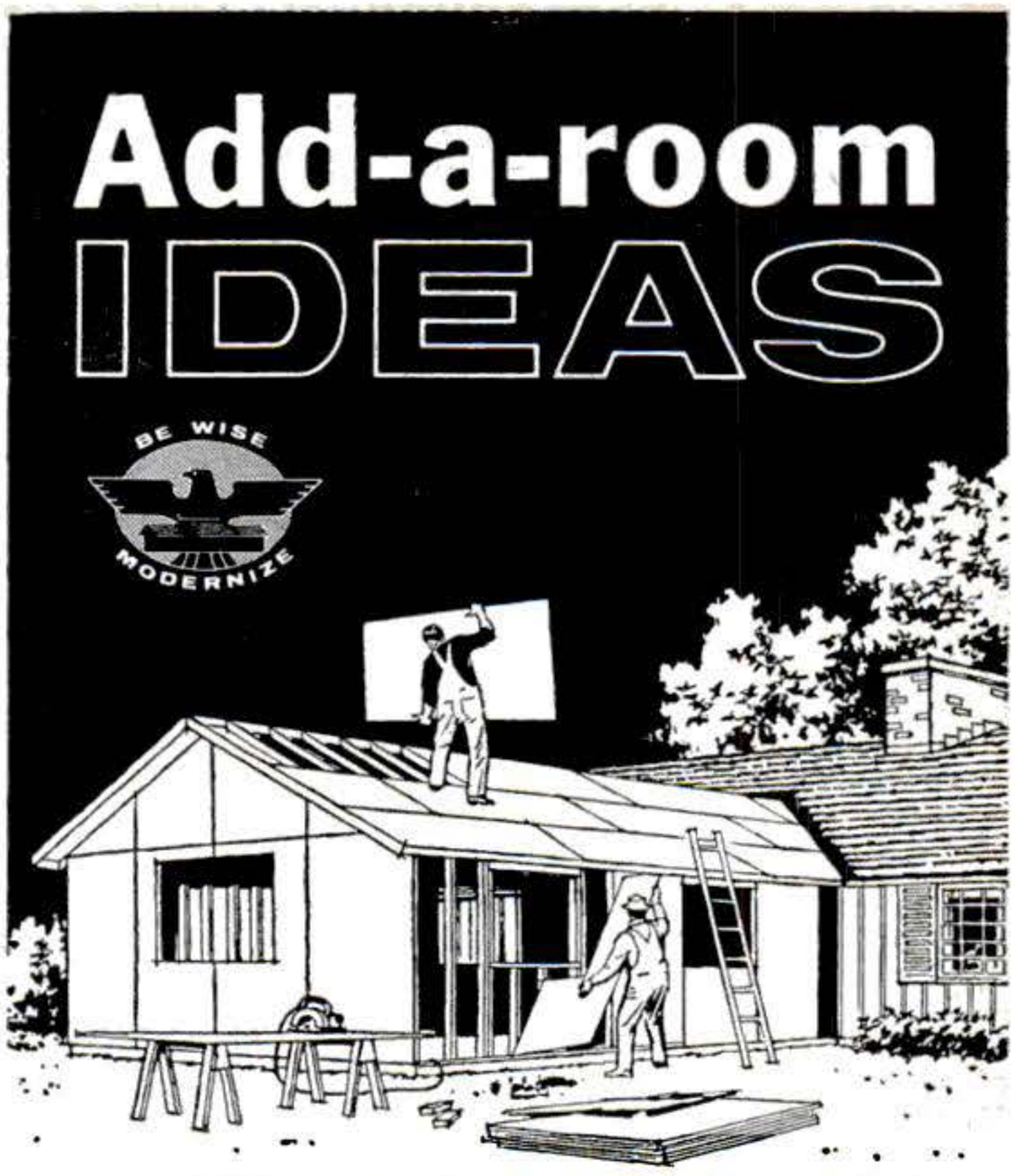
To lick the problem, Rutherford is banking on some new tape, now at the laboratory stage. This is said to have greatly increased packing density of the iron oxide particles, amounting to an amorphous magnetic layer on the quarter-inch plastic ribbon.

With the new tape, band-width acceptance will extend to three megacycles, making the recorder suitable for 625-line scanning, to which British television starts changing over next year. It may even be possible to lower tape speed to 60 i.p.s. without sacrificing quality. The present 120-inch rate limits double-track playing time to a total of 30 minutes with 9,000 feet of triple-play Mylar-based tape on a 10-inch reel. The recorder will take an 11½-inch spool, holding 13,500 feet for a 45-minute run. But increasing reel diameter just by this small amount means that winding and braking power has to be raised by 50 percent to handle the greater inertia, making the machine more costly.

Dramatic possibilities lie ahead when teething troubles are over. One is a new kind of pay TV, for which you would rent or buy prerecorded video tapes of the latest movies and plays.

For producers this would provide an extended market not confined to a geographical area based on transmission range. Subscribers might be sent canned shows regularly, like the Book of the Month.

Home movies are seen as a phase-two operation. Rutherford estimates that a TV camera could sell for $100, providing production reached the 100,000 figure. Initially your TV set or a small portable viewer would be used to monitor movie taping. Later there might be some kind of an electronic viewfinder for outdoor work that would indicate critical light values directly at the camera. ■■



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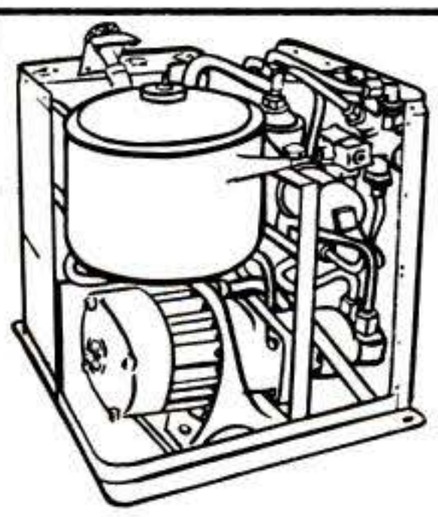

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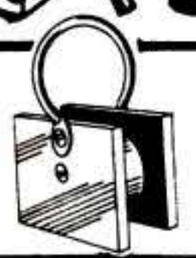

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[*Continued from page 99*]

color, in fact, may depend on two genes. And skin color seems to depend on at least six pairs. That's why the mulatto children of a Negro mother and a Caucasian father have dusky brown skin; they inherit some dark-skin genes from their mother and some light-skin genes from their father.

What color will the child of a mulatto couple be?

Since both of these parents can pass along either dark-skin or light-skin genes, a wide range of combinations is possible. Their child's skin might be black, white, or a shade between.

Could seemingly white parents have a black child, revealing the existence of "blood" from a Negro ancestor many generations ago?

A lot of overripe fiction depends on this idea, but *both* parents would have to pass on a full set of Negroid genes between them to produce a black child. And if the parents are "seemingly white" that's impossible.

What is "tainted blood?"

A lot of malarkey. Blood *types* are set by genes, and are therefore inherited. But blood itself is not inherited. During pregnancy, chemicals from the mother's blood enter her child's blood system, but her blood does not.

Will my children inherit my talents?

Maybe. Ability does run in families. So many Bachs were outstanding musicians that in Germany the family name became a synonym for organist. Generation after generation of Bernoullis were topflight mathematicians. It could have been something in their genes.

But suppose my wife and I are just average people? Does that mean our children must be?

Hardly. Lincoln, Franklin, Einstein, and Edison all came from families nobody had ever heard of. Great achievement undoubtedly requires a rare combination of genes. But the human race's total supply of genes is so mixed that the genius combination might turn up anywhere.

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Do you have to inherit talent?

Some parts of it are either in you or they're not. But training permits the talent to grow.

How far can heredity be transmitted?

Indefinitely. After all, you have eyes just like the eyes of people who lived 5,000 or 10,000 years ago. You must have genes that existed then.

What about people who boast of virtues inherited from somebody who came over on the Mayflower?

They're stretching the facts. Once you go beyond your father and mother you cannot tell precisely whom your genes came from. On the average, you would expect to get one-fourth of your genes from each grandparent. Yet it's possible that your mother passed on to you only the half of her genes that she got from her mother, so you wouldn't be related to your maternal grandfather at all. You can see how the likelihood of inheriting certain genes—or bearing the traits of some special person—decreases as your family tree spreads: eight great-grandparents, 16 great-great-grandparents . . .

Does heredity ever change? Or are human variations just the result of different mixtures of the same old genes?

Once in a while a gene does change, or mutate. During your lifetime you can expect three or four such mutations.

What makes the gene change?

Cosmic rays, mostly. These powerful atomic particles from outer space smash into the gene and alter the structure of its DNA molecule. Other influences—heat, X rays, radiation from A-bomb fallout, chemical treatment—also cause changes.

Is that the only way hereditary changes occur? What about the Russian scientist who says that conditions of life do affect future generations? Didn't he sort of "train" wheat seeds to stand arctic cold by growing the plants farther and farther north?

Radiation, temperature, and so on are "conditions of life," and they do change

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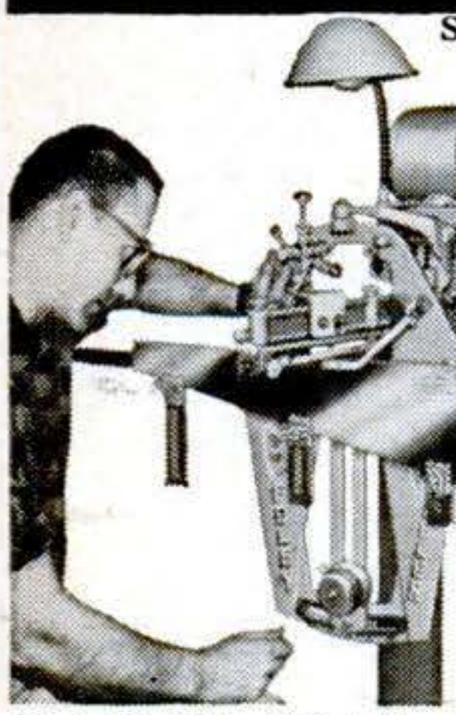

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heredity. But Western scientists believe such changes are more likely to be random, not aimed in one favored direction as the Russian, Trofim Lysenko, claims.

Do mutations cause big changes?

Each individual mutation changes the chemistry of one gene—altering one formula. Something new gets made or something old doesn't get made. One such change may have only a small effect, but it shouldn't be discounted. After all, life's processes are delicately balanced. A single change could throw the whole system out of whack. That's why there's so much worry about fallout: radiation increases the mutation rate—mistakes pile up.

Are mutations always mistakes?

In the sense that they represent deviations from a successful pattern, yes. Hemophilia, the bleeding disease, for example, apparently was introduced into European ruling families by a mutation of a gene in Queen Victoria's father. From her it passed on to harm some of her male descendants.

Why only male?

This particular mutation was sex-linked —carried in the X chromosome. A female might carry the defective gene in one X chromosome, but assuming her other X chromosome were healthy, the defect would be masked. Not so with the male child. If he inherits a defective X from his mother, the Y chromosome he gets from his father can't dominate it. He'll be a bleeder.

Are there any "good" mutations?

Well, during many millions of years, mutation after mutation combined to change some unknown sea creature into an amphibian, then an apelike mammal, and finally into a human being.

On a less cosmic scale such pleasures of life as pink dogwood blossoms, Delicious apples, and navel oranges are all the result of chance mutations.

Was evolution just a series of lucky accidents?

Not entirely. Mutations may be accidental, but outside conditions determine which ones survive. If the change helps the individual to get along in the world, he has a better chance of living. And so do his descendants. ■■

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Its thrust is so great the F-1 can be tested only on an exceptionally heavy stand. These F-1 static-test stands are heavily reinforced concrete with girder frameworks anchored deep in granite. Huge high-pressure tanks of stainless-steel plate five inches thick feed propellants to the engine.

Accompanied by a security escort, I backed off a full mile to an observation post. From a buried blockhouse the countdown announcer barked, "Ignition start!"

Shaking the earth. The mightiest motive power ever conceived for space erupted with the boom of Niagara. Flame from the F-1 roared out with volcanic force. Sound from the blast punched through the plugs in my ears and shock waves jolted the ground beneath my feet. A million and a half pounds of thrust thundered out from the F-1 combustion chamber.

For two and a half minutes, the actual time it will burn before being jettisoned in space, the F-1 thundered on. Then, with a noise like a pistol shot, it stopped instantly at the push of a button.

At Edwards, engineers in the underground control center observe firings via closed-circuit TV. Recording instruments gather up to 200 different measurements during a single test. This data flows by teletype to Rocketdyne's computer center a hundred miles away, at Canoga Park in the San Fernando Valley. Test information is then analyzed and fed back to the test site.

The engineers at Canoga Park told me that Rocketdyne has been working on the F-1 for four years. They've built a lot of rocket engines—for the Atlas, Thor, and Jupiter space boosters. Reliability is the motto at Rocketdyne—for men will ride atop the F-1 engines during preliminary flights and the actual moon shot. The F-1 engine has been test-fired more than 300 times, and the number of tests may reach 1,000 before it is finally man-rated.

Such thorough testing is necessary because the theory of rocket-engine design doesn't yet encompass all the things that happen when an engine is fired. "Combustion instability," for example, is a common problem, one that plagued the F-1 engine at first. What this amounts to is that uncontrolled explosions sometimes unpredictably take place inside the engine. Rocketdyne engineers solved that one by developing a secret means of decoupling

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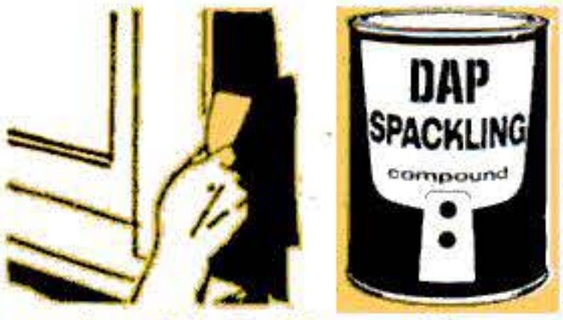

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vibrations inside the engine from the plumbing that feeds the propellants, so that different parts of the system cannot oscillate in resonance.

Cooling an inferno. The engine's fuel is RP-1—high-grade kerosene—and the oxidizer is liquid oxygen. The LOX flows into the engine at 300 degrees below zero, Fahrenheit, but then reacts with the kerosene to create a 5,000-degree inferno. To keep the engine from melting, its wall is made of metal tubes through which the kerosene circulates as a coolant before being injected into the combustion chamber. These tubes, though strengthened by a jacket of bands on the outside, are directly in contact with the burning gases inside the engine, unprotected by any lining. To make this cagelike chamber leakproof, the tubes are brazed together by heating the whole thrust-chamber assembly in a king-size furnace for almost 24 hours.

Feeding propellants into the engine are massive pipes leading from a turbopump that sits atop the engine. When you look at this pump, its compactness is deceptive. It's big, all right, but not as big as you might think for the job it has to do. That turbopump forces three tons of propellants (two tons of LOX to one of fuel) into the engine in a single second. Fuel economy is hardly the point in firing the F-1—in three seconds it uses as much fuel as the average automobile burns in a year. And its oxygen usage rate is equivalent to that of 60,000,000 people in normal breathing. To push fuel and oxidizer into the engine at that rate takes a 6,000 r.p.m. turbopump developing 60,000 horsepower—equal to 30 diesel locomotives working together.

There are actually two pumps, one for LOX and one for kerosene, mounted in-line on the same shaft with the turbine that drives them. The turbine is powered by hot gas from a "gas generator," essentially an oil burner consuming a fuel-rich mixture of the LOX and RP-1. To conserve space, the turbopump is mounted right on the thrust chamber, with other components nestled in the plumbing system between them.

Firing up. When the engine starts, electrically operated solenoid valves allow fuel and oxygen to flow by gravity from the tanks into the gas generator, where they are ignited by an electric spark. From then on, propellants feed from the high-pressure side of the pump into the gas generator, and no

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further electricity is needed to operate the engine. The high-pressure kerosene is used as a hydraulic fluid to operate the various valves of the engine, and even to operate the hydraulic actuators that gimbal the engine for steering in space.

The engine itself is ignited by a "hypergolic slug." That means that a "slug" of fluid is fed by a piston into the engine's injector ahead of the fuel, but while the liquid oxygen is already flowing through the injector. This fluid is "hypergolic with oxygen"—that is, it bursts into flame immediately on contact with oxygen. The kerosene then feeds into this flame, and away we go.

A cluster of five F-1 engines, each delivering 1,500,000 pounds of thrust, will develop a total thrust of 7,500,000 pounds, the boost needed to lift the Saturn V into space. There, the upper stages fire, powered by J-2 engines. Rocketdyne's J-2, with a thrust of 200,000 pounds, is the F-1's kid brother. The upper stage engines impart escape velocity to the payload, sending it on its way. This booster power is the key to putting man on the moon, and the F-1 engine is today the biggest rocket engine in the world. ■■

What's New at Ford

[*continued from page 82*]

tarnish. It doesn't have to be zipped out when the top comes down.

Falcon Ford's "compact" has a new body, new suspension, a steering wheel farther from the driver's chest—on the advice of stock-car racing drivers who like to steer with arms straight out.

Thunderbird A longer hood (for that appearance of power) and a shorter roof line characterize the Bird's first fresh styling in three years. New carburetion goads the performance. Wheels are bigger. The new tires are 8.15 by 15.

Fairlane Among the five engine options in 1963, one has been boosted from 145 to 195 horsepower. The top engine remains at 271. The styling, heretofore for a maiden aunt, has dash.

A new sports car, now incubating, may turn up in the company's 1964½ models next January. ■■

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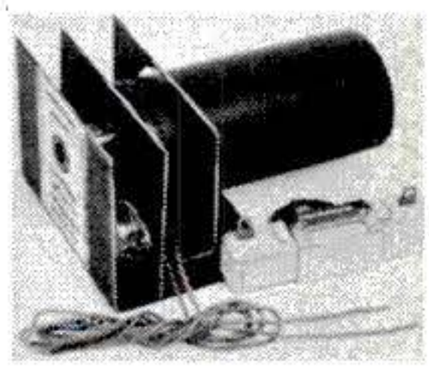

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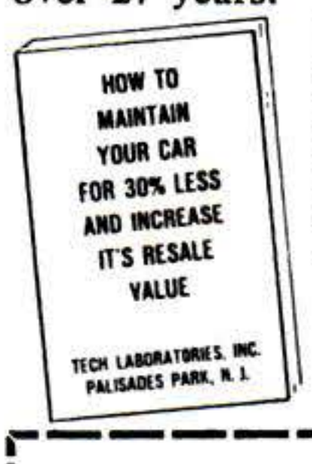

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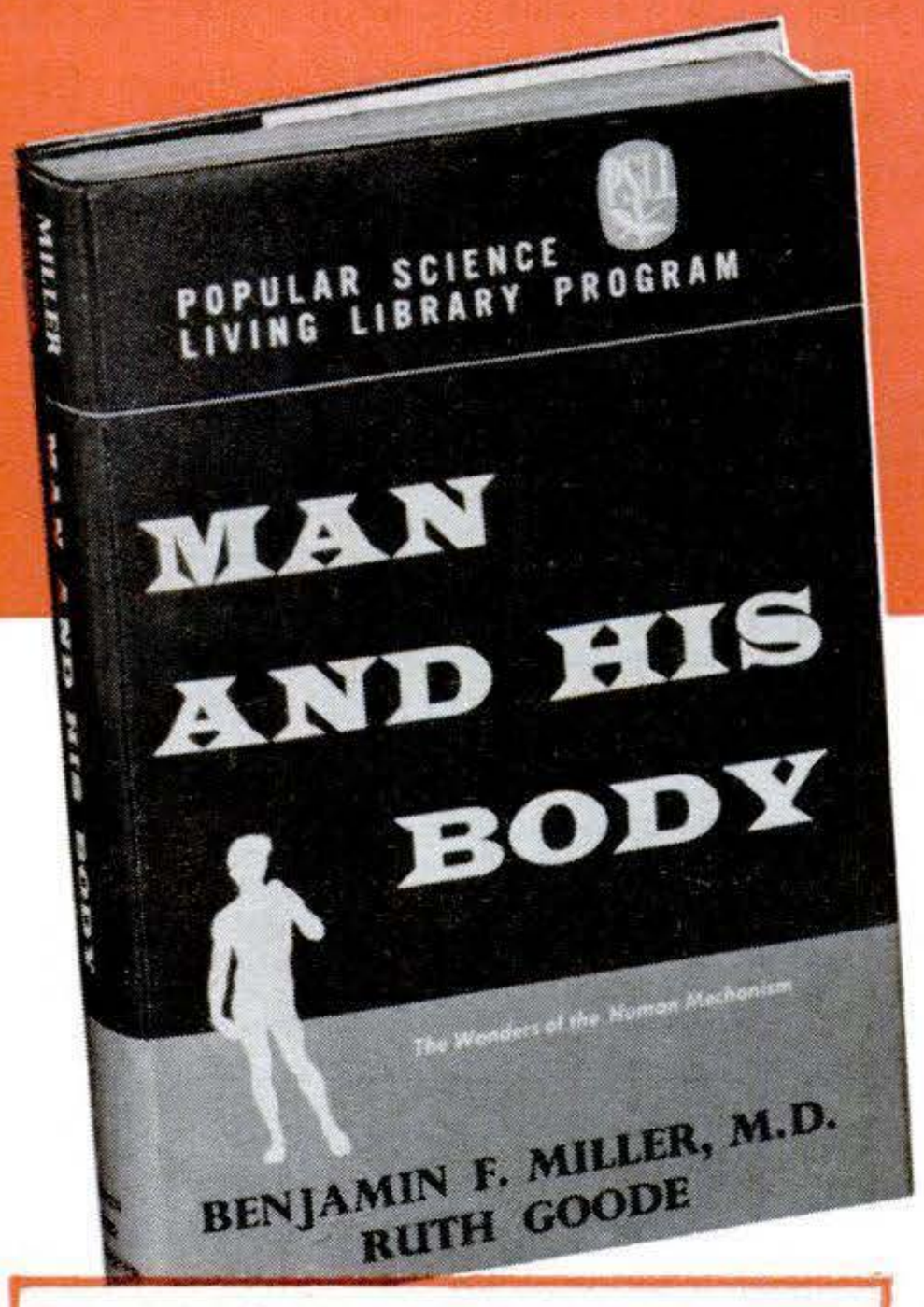

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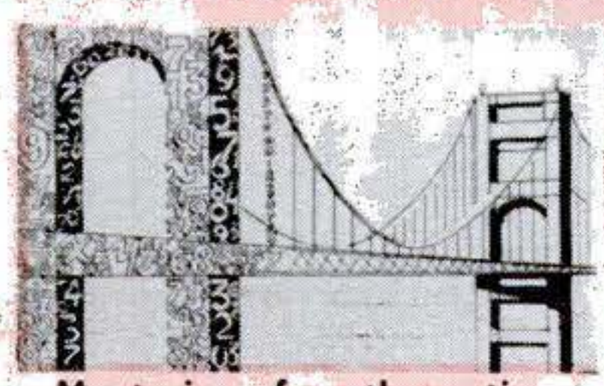

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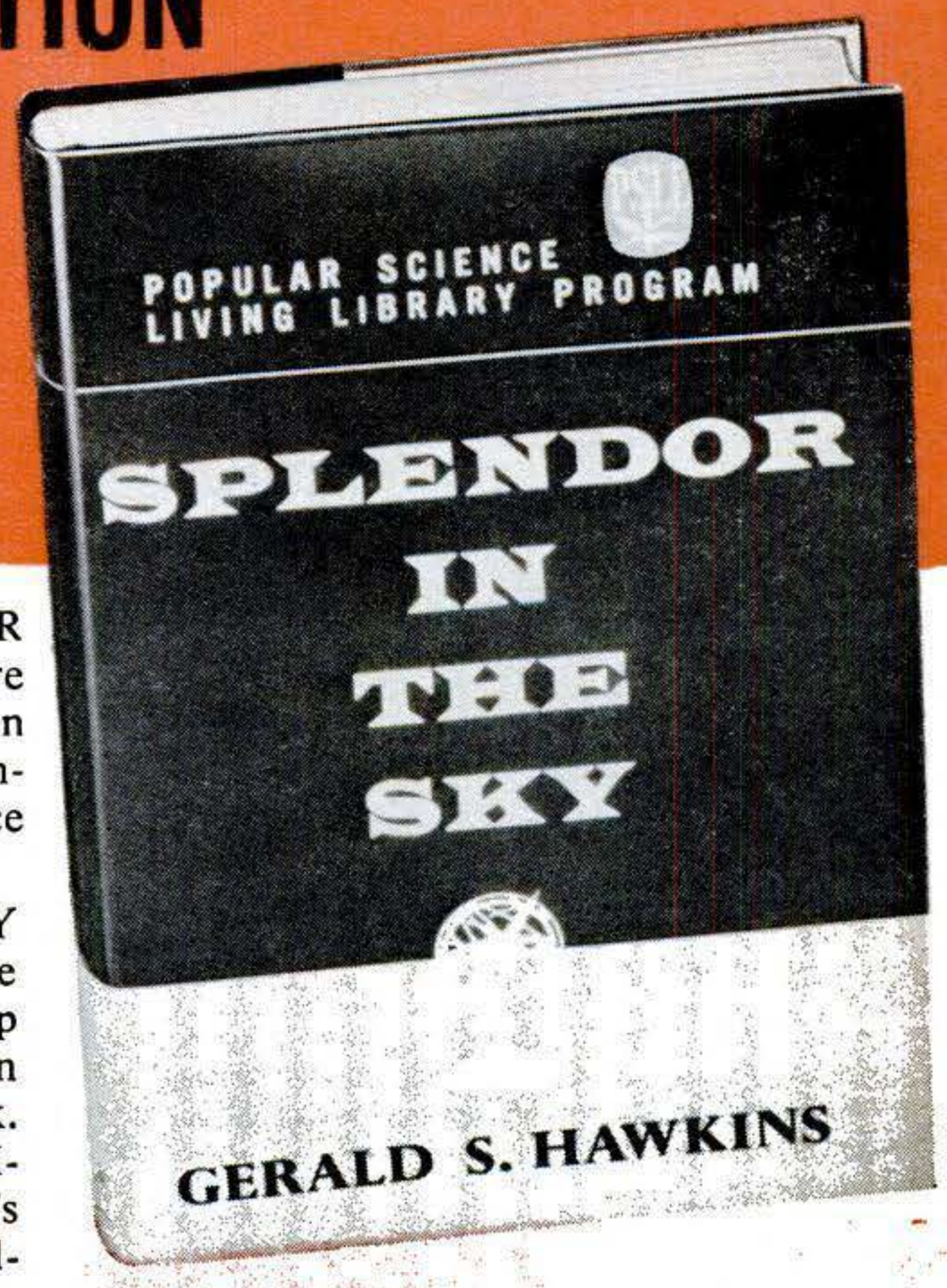

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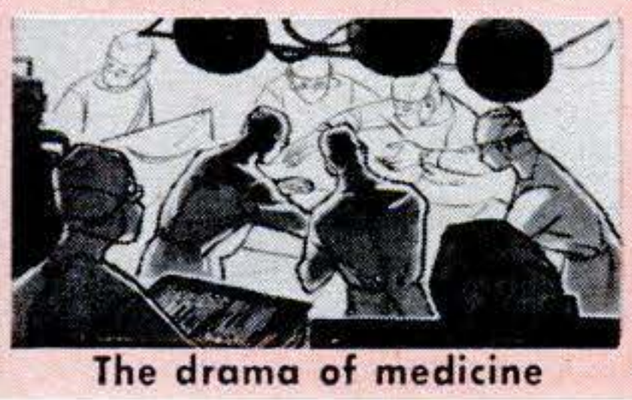
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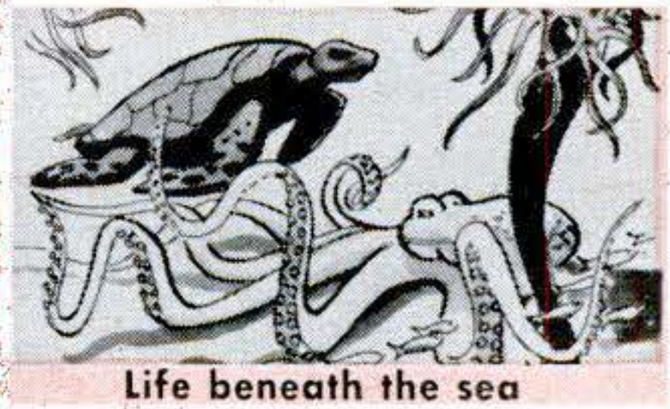
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The Midget Lathe That Does Mighty Jobs

[Continued from page 149]

chine, and they pile up fast, especially in the screw sockets.

I thought the metric threads on the feed screws would be confusing. But they work out handily in inches. One turn of a feed wheel advances matters by one millimeter, or .03937″. That's 40 thou for any but the most hairsplitting work. Each of the 20 divisions on the feed collars—.05 millimeters on the metric scale—rounds out neatly to .002″.

I also like the English-style tool post—a solid steel block with a slot for the bit. Clamp in a properly ground tool, and the cutting edge is automatically at center height. It's more foolproof than our rocker-arm tool post, especially for beginners.

Tool travel and adjustments are modest except for the longitudinal feed, which can run the carriage right up to the spindle. Cross-feed is $1\frac{5}{16}$″. Tailstock-ram travel is a skimpy $\frac{3}{4}$″. But the spindle can be advanced $\frac{11}{16}$″ (with a hand lever as on a drill press) in addition to ram travel for such work as horizontal drilling.

As a lathe. The Unimat peeled $\frac{7}{8}$″ brass down to $\frac{25}{32}$″—a hefty cut—in one smooth pass without a whimper. Next I chucked a 1″-diameter rough iron casting. If you don't get under the scale with the first cut, the bit usually dulls fast, but to do so means taking a big bite. With some misgivings I fed the tool in. To my surprise it turned off the scale handily, producing a smooth surface in one pass. With the slow-speed attachment (available as an accessory), I'm convinced the Unimat could handle larger castings, too.

Turning a crankshaft from the solid is also a demanding job. The sight of a piece of shafting spinning on offset centers almost deterred me from this because the interrupted cut for the crankpin has to be made with a parting-type tool, a wicked load for a small machine.

My home-ground, $\frac{1}{16}$″-wide round-nose tool chattered badly at first. Then I learned to give it a little side motion while advancing it to cutting depth. Soon I was taking off 20 thou at each pass and getting a good finish.

The power-feed attachment. This is a new accessory. Belt-driven from the spindle, it advances the carriage .0008″ with each spindle turn. On free-machining brass and aluminum, it spins off continuous chips

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as long as a flapper's necklace. If you let it run against a shoulder or the chuck, the chances are the belt will slip instead of breaking the lead-screw bearing, as this sort of boo-boo does on big lathes.

Taper turning seems impossible at first. There's no compound rest you can feed at the required angle, and the tailstock cannot be set over. Instead, you clamp the headstock at an angle to the ways and advance the tool with either the longitudinal feed or the cross-feed. You can even turn tapers between centers by mounting the work between the angled headstock and the fixed tailstock. It's an odd-ball setup, but it works.

Re-aligning the headstock is much easier than resetting a tailstock. A registry pin aligns it within one degree. For dead-on accuracy, you simply leave the headstock free to swivel and slowly feed the tailstock center into the spindle hole until it centers, then tighten the clamping screw.

Setting up the drill press. Here you use another neat trick: Screw the faceplate to the spindle and lower it onto the cross slide. The sensitive quill feed and high available speeds make it possible to do precision drilling down to size 80. At the other end of the scale, you can use a fly cutter or, with power off, do tapping.

Milling is a touchy operation and caused chatter when the cut was heavy or the work overhang was excessive, as it will on any machine. Horizontal milling is limited as there is no vertical adjustment in this operation. However, some facing and grooving cuts made with the work clamped on the slide rest were excellent.

In a vertical milling setup, the quill feed can be used to advance the cutter between passes. A ⅛″ end mill made $\frac{1}{16}$″-deep passes in aluminum without a bit of chatter. A ½″ keyway cutter milled a difficult angle slot at 1/64″ per pass.

Encouraged by this, I set up the indexing attachment to mill three deep notches in a $\frac{3}{16}$″-by-1″ steel disk. My cutter was an old twist drill reground as an end mill. The setup had a deplorable amount of overhang. With a gentle feed, the notches were painfully milled out, a severe test of the Unimat's ability to take punishment. (What I should have done was to mount the work horizontally to bring the load directly over the lathe bed and use the quill feed to move the cutter.)

CONTINUED

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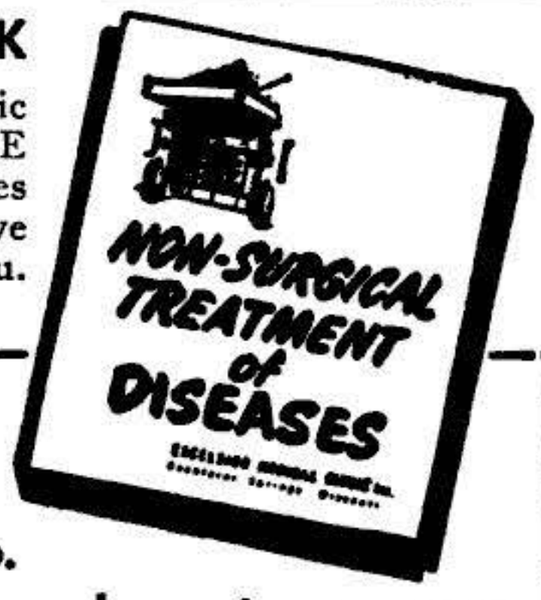

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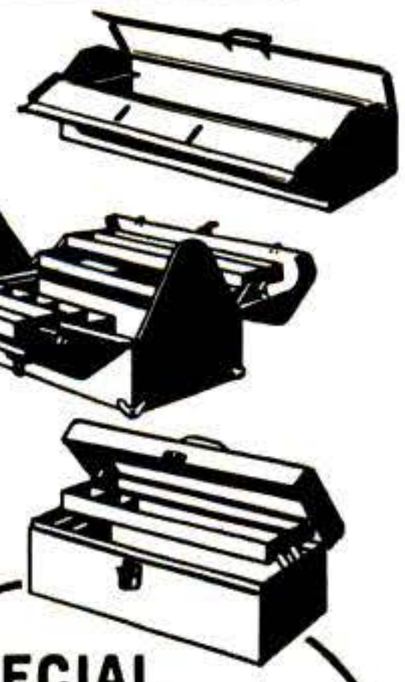

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Surface grinding. You don't normally dream of surface grinding with home-shop equipment. But it's perfectly feasible with the Unimat. A cup wheel mounted vertically grinds true flats on work bolted to the slide rest or milling table or held in an accessory vise. You can put an edge on homemade reamers or sharpen milling cutters. Tilting the headstock makes it possible to grind dovetail cutters and other angled work.

How can it cut threads without a geared lead screw? By means of a master pattern, a steel collar with a thread of the desired pitch bolted to the back of the chuck. As this turns with the work, a brass follower rides the thread, advancing the tool holder.

Internal threads are cut the same way with a dropped tool holder. For multiple threads, you reposition the work in the chuck after cutting the first one.

Complaint department. My main beef about the Unimat is the three-jaw chuck, a piece of steel jewelry with a locking ring instead of a key. Two hands don't seem enough to maneuver the two slippery little bars that lock and unlock it. Also, there is only one hole in the ring, and hunting it can be aggravating at times, especially in setups where it's impossible to turn the chuck.

A little more tailstock-ram travel would be helpful not only for drilling, but to permit more carriage feed on short work requiring tailstock support.

There is no index mark to read feed-collar markings against, a lack easily remedied by scribing or punching them. I just escaped jamming my thumb between the rotating feed handle and the housing of the feed gears. However, I don't think this is a serious hazard.

The round rubber drive belts are heavily loaded; I wore two to a frazzle in making the tests, so it's a good idea to have spares on hand. (New Unimats will have longer-lived V-section belts.)

All in all, the Unimat is a well-built and surprisingly capable tool that can teach even old lathe hands some new tricks. For the beginner, it's close to ideal. Belt slip lets it forgive blunders that would cause expensive damage on bigger lathes. Yet the student can learn as much about cutting angles, tool settings, and machining sequences as on far costlier machines—and have a lot of fun doing it. ■■

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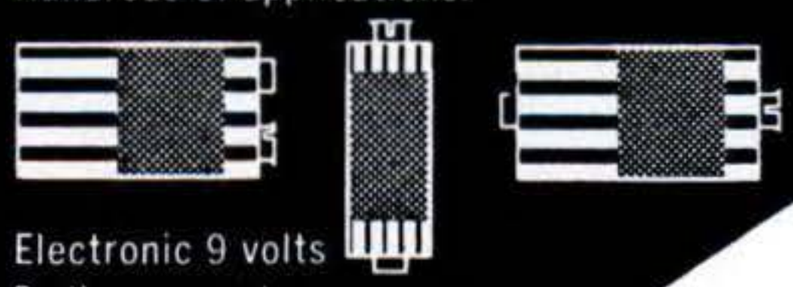

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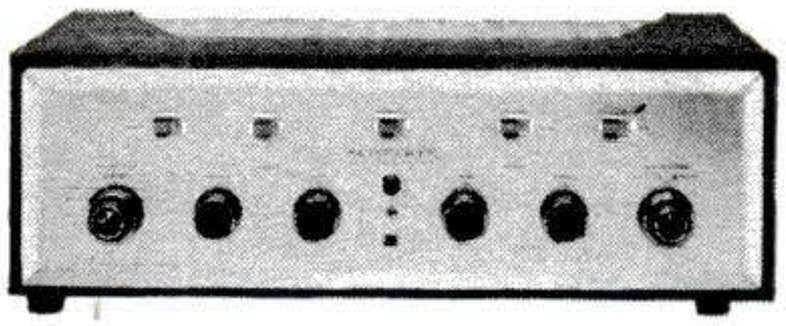

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All Steel and a Yard Wide

[*Continued from page 134*]

dope the line with asphalt, heated to several hundred degrees in a tractor-mounted tank standing beside it. After one application, the outfit bandaged the pipe with a layer of fiberglass and topped that off with a wrapping of black asbestos felt.

The asphalt was a must for the rust-vulnerable steel line. So was a careful check to make sure there were no holes, or "holidays," in the jacket. The inspecting method was simple. An electrically charged spring wrapper was passed over the surface. If juice jumped to the pipe, the spot was marked for patching.

I asked Pat whether another enemy of metal—electrolysis—posed any pipeline problem.

"They have two ways of licking that," he said. "One is to bond the line to magnesium or zinc anodes buried in the ground. Instead of eating away the pipe, the destructive current goes to work on these sacrificial anodes.

"With the other system, a number of graphite anodes are buried several hundred feet from the line. Current is fed to the line and taken off by a cable connecting the anodes and the pipeline. The anodes are sacrificed instead of the pipe."

We had now come out on the highway again. The Yard-Wide will cross many public roads between Houston and New York. To avoid disrupting traffic, steel casing up to 42 inches in diameter is first poked under the pavement. Then the pipe is threaded through.

Pat pointed to a crane bedding a slab of concrete in one of the shoulders. "There's another pipeline guardian," he said. "Should a road-maintenance grader start playing around too close to the casing, its blade will strike that shield first."

An engineer had just wheeled up in his jeep. "It'd pay you to drive over to the double-jointing yard," he said. "That's where you'll see how the joints are buttoned together."

Three-minute barbecue. Locating the yard was easy; we followed a deadheading pipe truck. Ten of these rigs were cycling between the yard and the work site. I'd already crawled under one to inspect an ingenious crisscross of cables that automatically steered the trailer wheels in the opposite direction from those up front on turns. The setup even provided a slight

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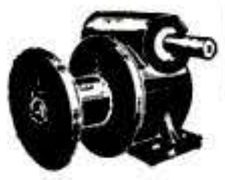

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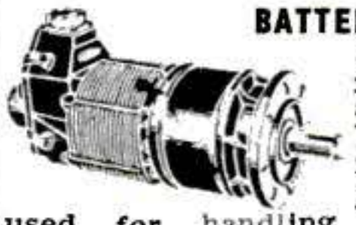

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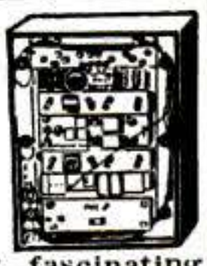

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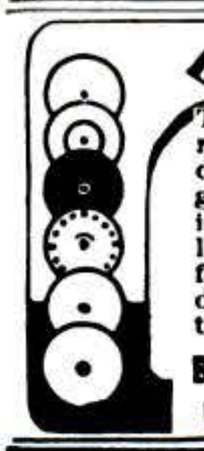

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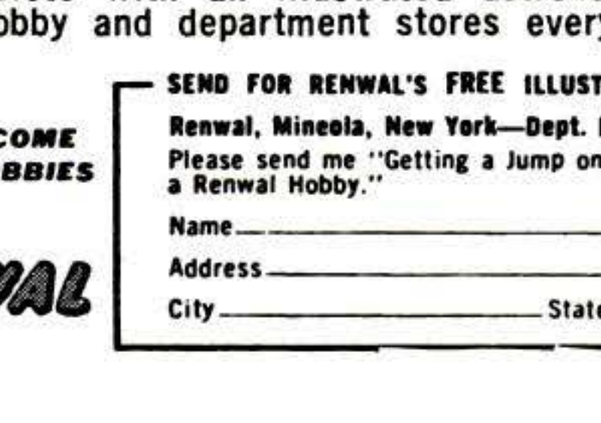

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When we reached the yard, an oversize tractor, half hidden under prehensile steel arms, was raising so much dust the operator wore a respirator. Every 90 seconds this Cary Lift pulled up to a stockpile of 40-foot pipe joints, plucked one from the heap, and hustled it to a broad ramp formed of parallel girders.

Underlying cribbing gave that gravity conveyor just enough pitch to feed pairs of joints, placed end to end, into a set of clamps that rotated them slowly on a fixed axis. While they were turning, grinders burnished their beveled ends and a stationary welder filled the trough with a slick bead of molten metal.

Next stop was an internal welding station. There, an operator lying on a motor-driven crawler skated into one of the big cylinders every three minutes to apply a pound of electrode wire. All that kept him from being barbecued was a blast of air belted at him by a six-foot fan at the far end of the pipe.

The third and final operation was a weld-joint X-ray test. Passing that, the double joints were rolled onto the waiting tractor-trailer trucks.

Pipelining in the coastal swamps. Observing hardrock operations, I'd figured a contractor could save himself grief by bidding on chores near the Gulf Coast. I changed my mind next morning. At Orange, Tex., the paymaster of the outfit working Spread Two met us at a marina. As we skimmed down the Sabine River in his runabout, he called our attention to the undercut banks.

"We've had more than six inches of rain this week," he said. "Even the cottonmouth moccasins don't like it. We uncovered 20 yesterday, coiled together on the highest ground they could find. Every crew in these parts carries a stretcher and a snakebite kit."

We nosed ashore below the Intracoastal Waterway and slogged across the swamps to a fleet of pipe layers mired in the gumbo. The weight of the section of line these Cats were bedding had pressed their inboard crawlers down through four feet of the toothpaste-like clay.

That cocked the big machines over 45 degrees. Even their fully extended counter-

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weights couldn't have kept them from flipping into the ditch. So four bulldozers were backing them up. Each had its blade set, like a huge restraining hand, on one of the 5,200-pound steel bundles.

I asked the field boss how he expected to free the outfits for the next drop.

"We're counting on that water buffalo over there," he said, pointing to a dozer with three-foot lengths of heavy oak cribbing bolted to her shoe plates. "With those skids she could walk on a bowl of hominy grits. We'll tie her to one pipe layer after another, gun the diesels, and something's bound to give."

The adjacent trench was flooded to the brim, except for a diked-off stretch where the line was being tucked in. There, a battery of pumps was trying to hold back the water until the pipe could be lowered in and pinned to the bottom with pipe anchors and backfill.

Joining Texas and Louisiana. Farther downstream, a section of the Yard-Wide was being readied for the Sabine River crossing. The concrete-coated pipe had been strung together at right angles to the river, next to a trench gouged out on the Louisiana side.

Now the line was slung beneath floats and lowered into the water-filled trench. From there it would be towed straight across the Sabine to the Texas shore.

"Once it's spotted above the river-bottom ditch," Pat said, "the floats will be removed and the pipe will drop right in the groove."

Two hours later we were backtracking toward Atlanta in the Beech. This was the first time we had flown comfortably high above the thermals at full cruising speed. Ten thousand feet below us, the Yard-Wide was a barely visible thread. Under next year's cover crops it would completely disappear.

"Funny thing," I said. "One team of construction men builds a $326-million Glen Canyon Dam in Arizona, and tourists travel thousands of miles to admire their handiwork. Another outfit puts in as much savvy and sweat on a $360-million pipeline, and everyone's glad it's going to be out-of-sight underground."

Pat shrugged. "Maybe the pipeliners' monument," he said, "is all those barrels of regular and premium gas the tourists will use to get to Glen Canyon." ■■

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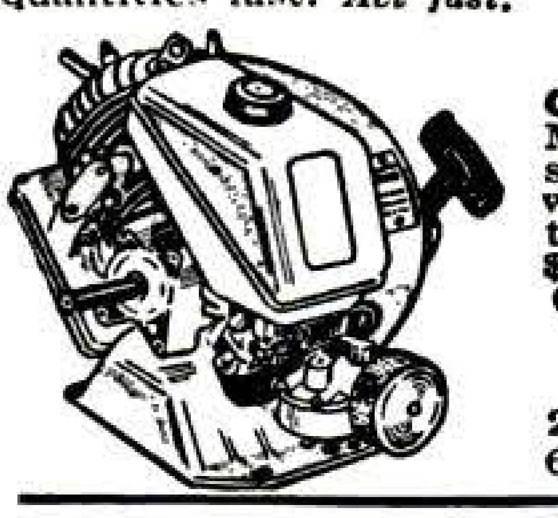

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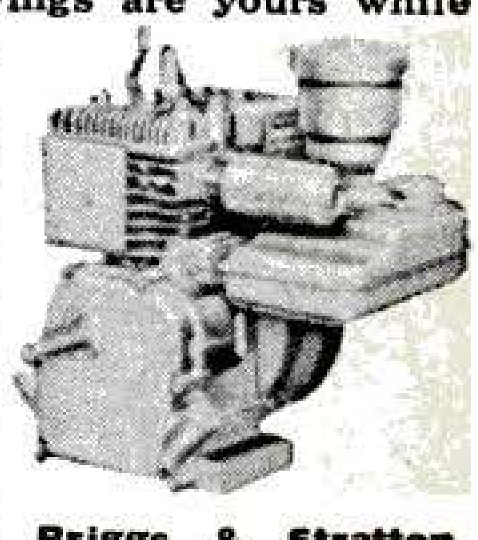

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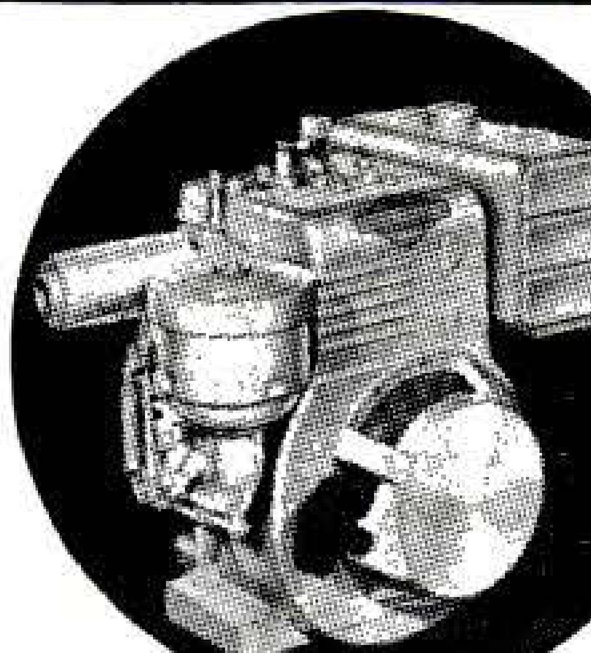

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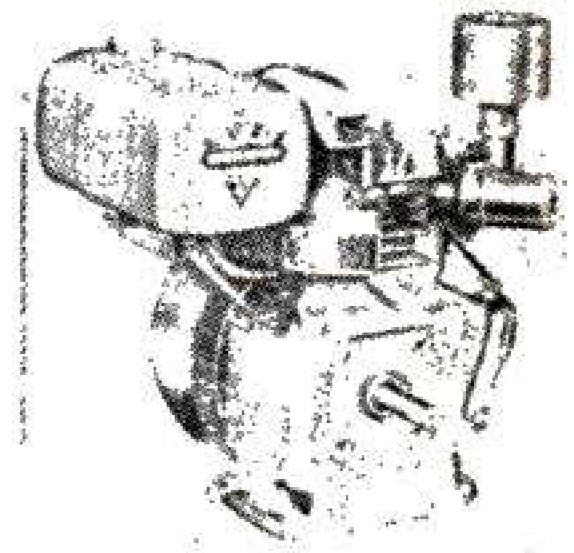

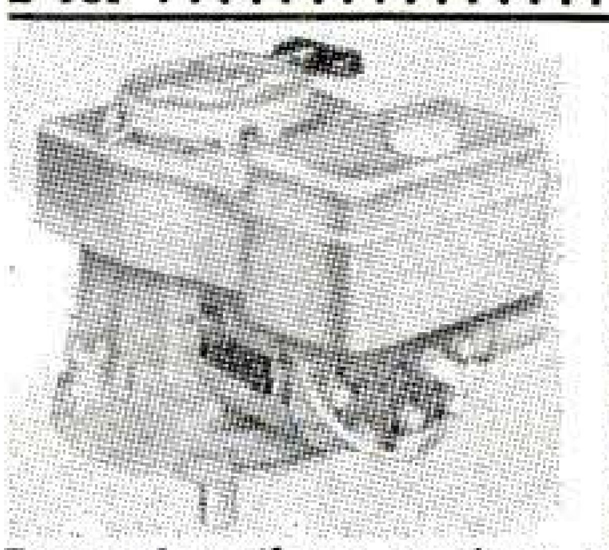

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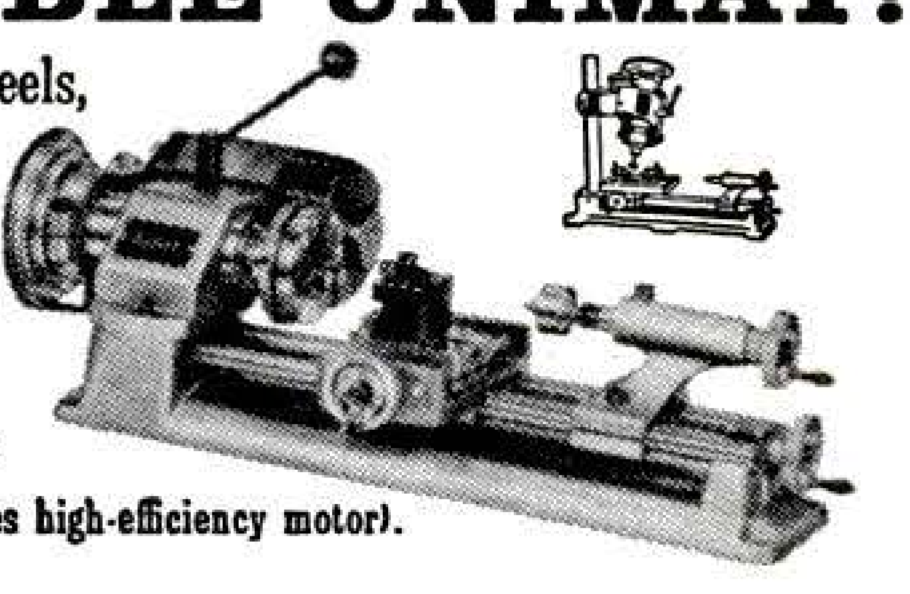

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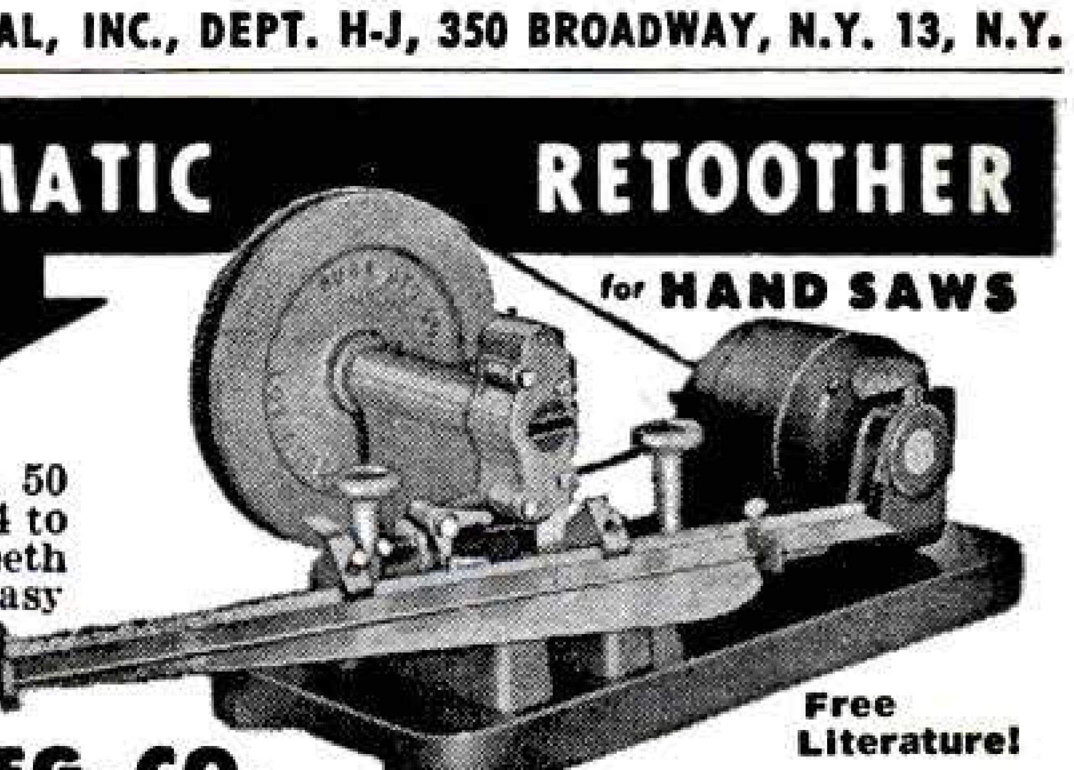

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How to Make Your Own Plastic Bearings

[Continued from page 157]

Special epoxies for bonding each of the three materials are available.

Buying stock plastics. The cost of bearing plastics makes it uneconomical to buy an extensive variety. Here is a suggested list that will meet most needs:

- ½" and ⅝" i.d. nylon or Teflon extruded rod for common shaft bearings.
- 1½" to 2½" nylon or Delrin bar for cams, casters, small gears, idler sprockets.
- ⅛" through ⅜" nylon pressure tubing for small-diameter shaft bearings.
- Roll of pressure-sensitive Teflon tape for sliding bearings.
- 1"-diameter rod for machining special glides, flanged bushings, rollers.
- Piece of ⅜"-½" plate, strip, or flat bar for wear blocks and guide shoes.
- 1/32" Teflon sheet for wraparound sleeve bearings.

A great variety of plastic-bearing stock materials is available at most commercial plastic stores. Cadillac Plastic Co., with stores in 22 cities and headquarters at 115111 Second Avenue, Detroit 3, for example, caters to small users. They will send catalogue sheets, quote on specific needs, and fill mail orders ($5 minimum).

Most bearing plastics are sold in minimum quantities, often one foot. Prices vary considerably: ½"-by-1" nylon tubular bar costs about $2.75 per foot, while ⅜"-by-½" nylon pressure tubing goes for only about 60 cents per foot.

Design tips. When repairs (particularly on a shop-built device) call for plastic bearings, here are some tips to help get the most from the materials:

- When it is not possible to use plastic for the bearing, consider using a plastic shaft and a metal bearing.
- Avoid running plastic against plastic.
- Use these guidelines for determining running clearances for bearings: nylon and Teflon to 150 degrees running temperature, ¼" to ½" shaft diameters—.002" to .004" clearance; ⅝" to 1"—.004" to .006" clearance; 1¼" to 2" diameters—.006" to .010" clearance. Delrin and Teflon to 250 degrees need almost twice the clearance given above.
- Keep bearing length under twice the shaft diameter for economy and for easier alignment. For example, bearings on a ¾" shaft should be no more than 1½" long.
- Keep bearing walls as thin as possible. Plastics are poor heat dissipators. ■■

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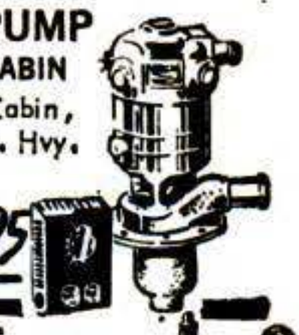

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Buick: Economy Plus Scat

[Continued from page 86]

Its 1964 replacement, made of thin-wall cast iron, weighs only 1.34.

Two new transmissions, tailored to cars of different weights, not only have more sass but absorb less fuel energy in delivering power from engine to wheels. One, behind a 360-horsepower engine, jumps the sporty Wildcat from 0 to 60 miles an hour in 8.9 seconds—on a rear axle reduced from 3.42:1 to 2.78 for economy.

The other transmission, with the same engine, propels the elegant Riviera to 60 in .7 of a second less. With the accelerator floored, the Riviera will scrub rubber on takeoff.

Buick's reworked V-6 turns out 155 hp. compared with 135 last year, and the new V-8 produces, in its mildest version, 210 compared with 155 for the aluminum one.

Buick's little Special, grown up, is now a sister to the stretched-out Pontiac Tempest and Olds F-85. In the model lineup it is teamed with the Skylark. Both roll on softer, more skidproof, two-ply tires. No longer is there an Invicta model. Buick's "big" cars are the LeSabre, Wildcat, and Electra.

Finally, in common with other General Motors cars, the automatic transmission selector quadrant reads P-R-N-D-L instead of P-N-D-L-R. ■■

Studebaker: An All-New Lark

[Continued from page 84]

expansion pistons that reduce wear; new piston rings for better oil control; new crankshaft design for weight reduction and better balance; accelerated water pump to improve engine cooling and heater operation; relocation of water takeoff to front of cylinder head, where water is hottest.

Studebaker also has jumped on the extended-interval chassis-lube bandwagon. Universal joints need no grease, front-wheel bearings only every 24,000 miles or 12 months. Tie-rod and reach-roll ball joints: every 24,000 miles or 24 months.

Door latches are stronger. A special aluminum primer that can be applied to surfaces before they are welded offers protection from internal rust.

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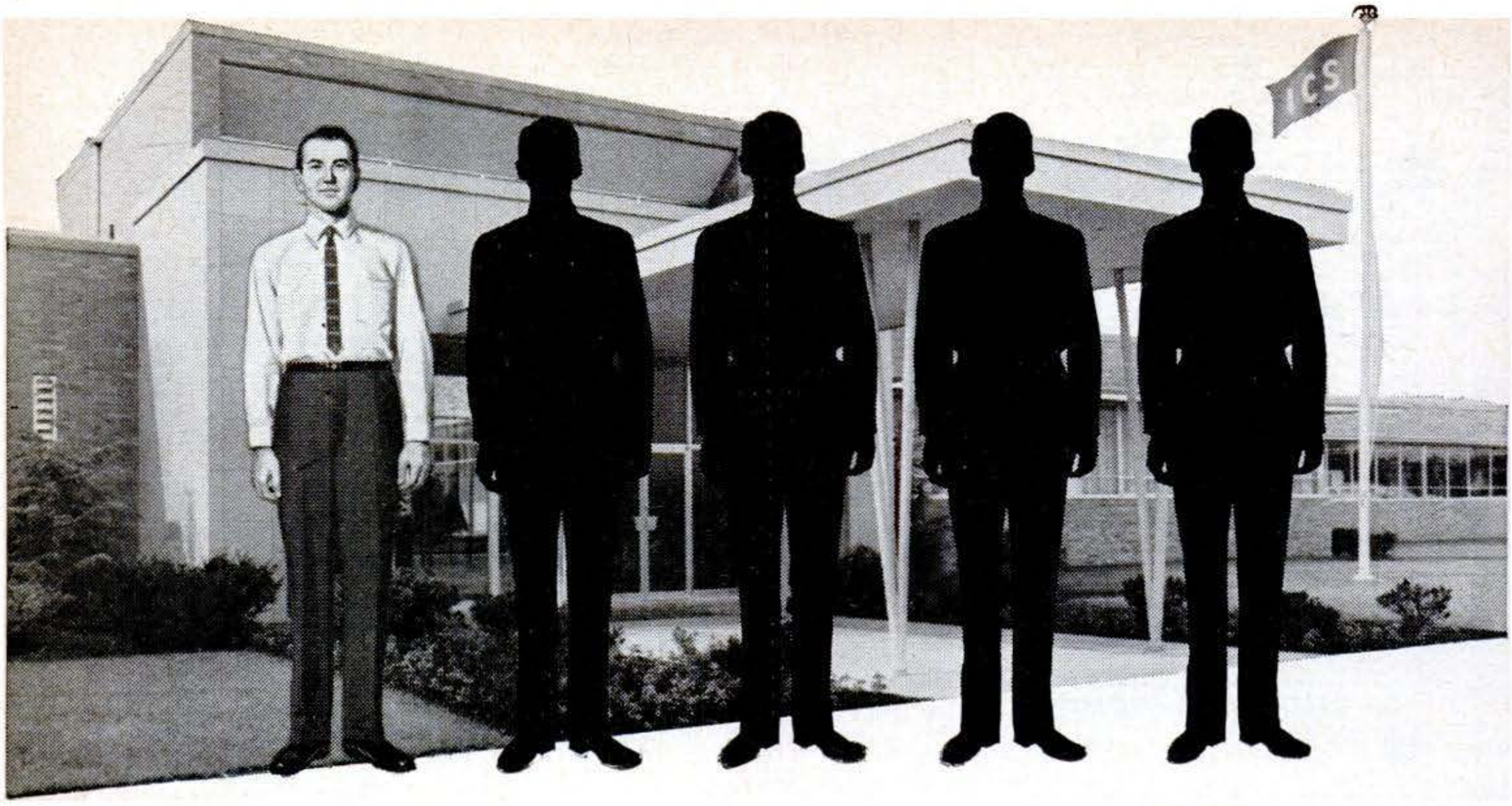

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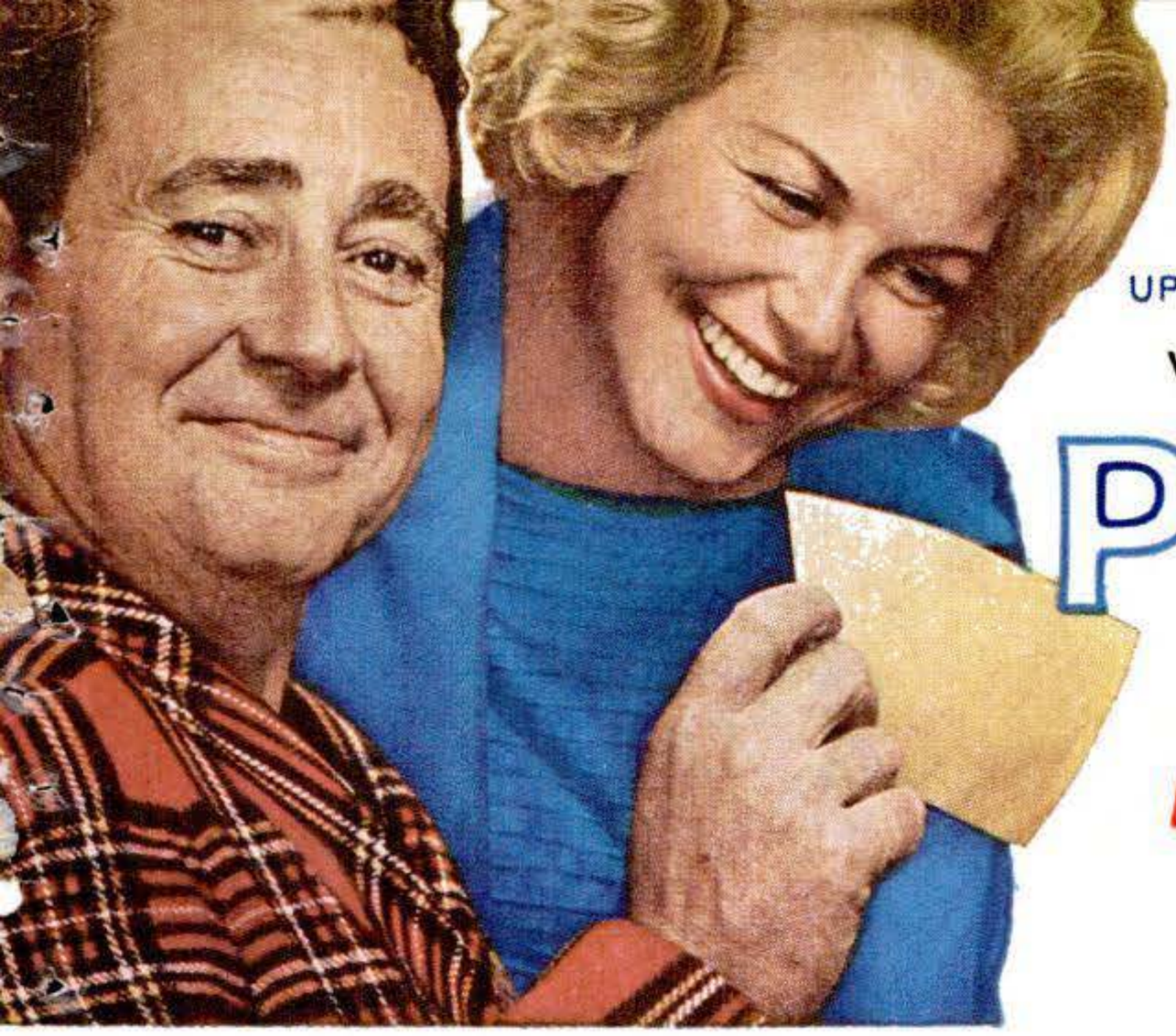

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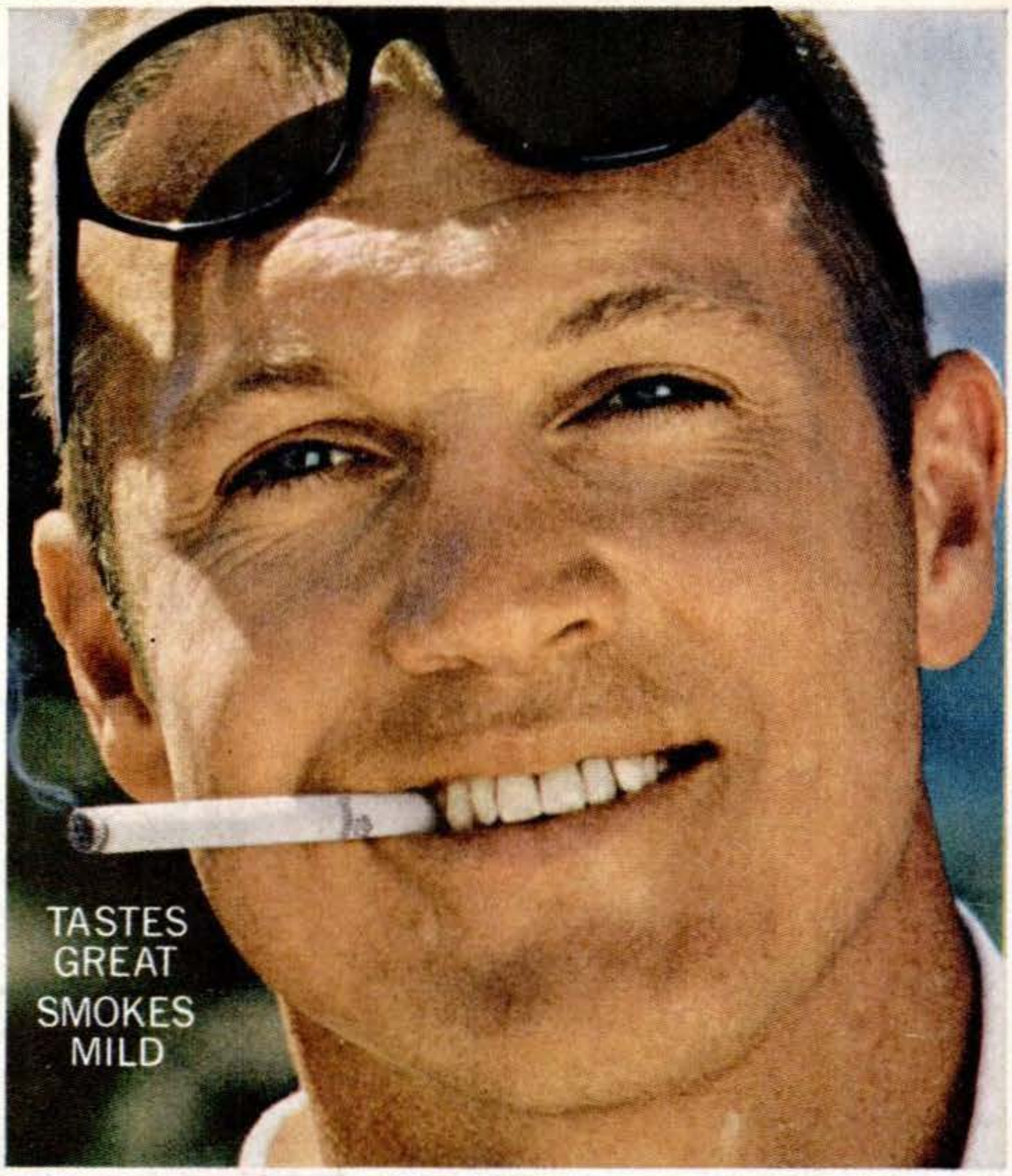

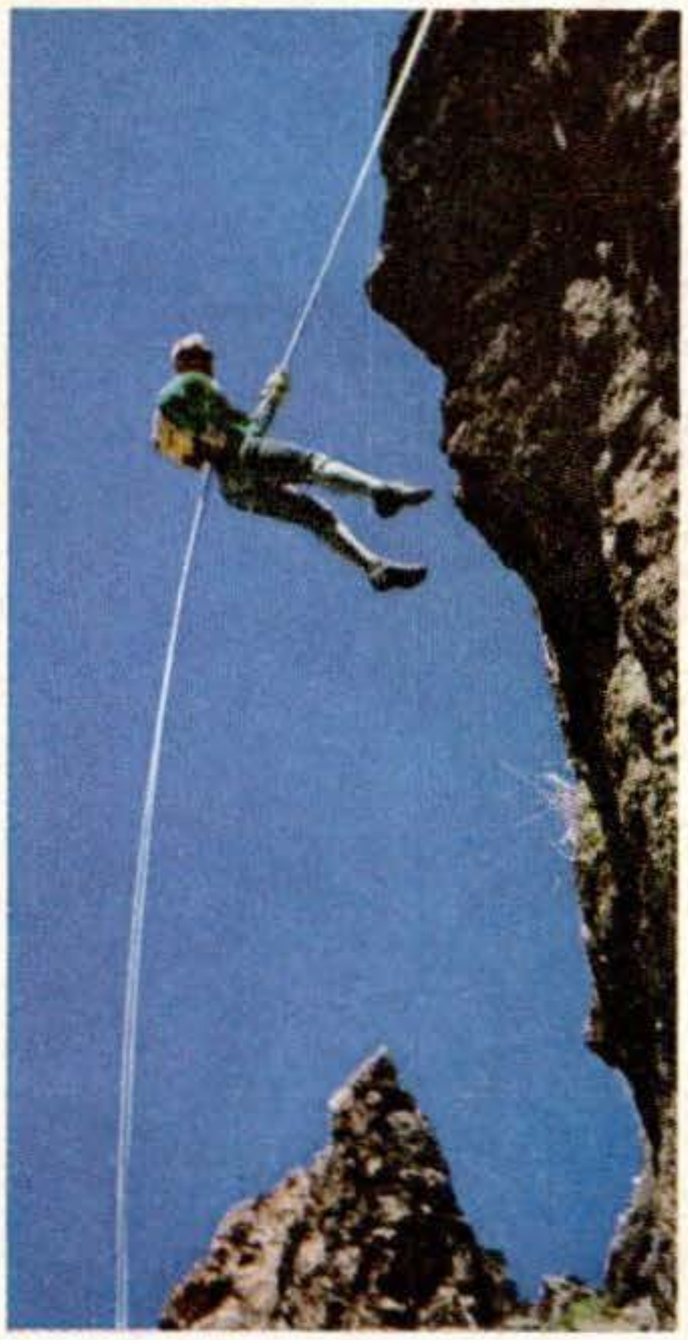

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